ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 65. No. 3. 220 Broadway, New York, January 19, 1911.

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ROOF OF 22ND REGIMENT ARMORY, NEW YORK CITY, DURING ERECTION.

(In foreground are the two traveling derricks with auxiliary booms, by which the entire column and roof steel was erected. Photograph taken Nov. 19, 1910.)

Erecting a Steel Arch Roof by Derrick with Auxiliary Boom.

In erecting the steelwork of the new armory for the 22d Regiment of the State Militia in New York City, the contractor employed to advantage a novel form of derrick which he designed for the work. The building is at 168th St. and Fort Washington Ave., Washington Heights, Manhattan. The three-hinged arches of the roof are peculiar in resting on the ends of cantilever extensions of the side columns (see the view herewith), a construction which was adopted for the sake of reducing waste floor-space, improving the lighting, and facilitating the gallery layout.* The building has two floors below the main or drill-hall floor; the ties which take the arch-thrust are in the drill-hall floor.

*A description of the design, with drawings, appeared in Eng. News of May 5, 1910, pp. 520-522.

In erecting the steel, the contractor first set the columns and beams of the middle two bays of the width, for the full length of the building. This furnished a level platform for doing the main part of the work, the side column and roof-truss erection.

The side columns were shop-assembled from base to eave splice, a length of about 50 ft., weighing about 5½ tons. The inclined cantilever section, carrying the arch hinge at its ex-

tremity, was shipped separate, but was required to be fitted and riveted to the column on the ground before erection, in order to insure accuracy. The assembled column thus weighed some 7 tons, and its shape made it unusually awkward to handle for its weight. The arch trusses, being braced in pairs, required supporting after being set in place until a full bay of bracing, or strutting to the last-erected truss, had been put in.

Two traveling A-frame derricks were designed for handling both column and arch erection, one derrick to command half the width of the building. In order to fit them for holding up the arches temporarily and setting the bracing members at the same time, they were equipped with auxiliary booms. As the adjoining view exhibits, the auxiliary boom is mounted on top of the A-frame of the derrick.

The derrick is mounted on a platform 40 ft. long by 30 ft. wide. The A-frame is 56 ft. high; two back legs hold it against the pull of the boom lines. The main boom is 72 ft. long. The auxiliary mast, 19 ft. high, rests on a sill fastened to the timbers of the A-frame, back of the head-sheaves. Two guys run from the top of the auxiliary mast to the back of the platform. The auxiliary boom, which is 40 ft. long, is stepped above the top of the A-frame so as not to interfere with the main boom rigging. A Buffalo 7½ × 10½-in. double-drum hoisting engine was mounted on the rear end of the platform. The hoisting lines of the upper boom were carried down over the lead blocks to winch heads on the engine.

The derrick platform was placed on rollers. The two derricks worked side by side. When first set up, they erected the side columns and the unfinished part of the floor steel, moving forward from one end of the building to the other. Then at the far end they set the first roof truss, and moving back they set all members of the roof in succession.

In placing the trusses, each derrick lifted up its half arch, set it on the end pins and lowered it until the two half arches were in bearing at the crown pin. Then the truss was left in position hanging from the lines of the main booms, and the auxiliary booms then set the braces and purlins. The first truss erected was braced by the inclined purlins of the end hip roof which is a feature of the architectural design of the building. All other trusses were secured by their tower bracing or by the purlin strutting to the preceding truss forming part of a completed tower. Thus, no falsework or temporary bracing or staying was required for the erection.*

These derricks proved very efficient and satisfactory. They erected the twelve arches and all the other steelwork of the roof in 16 days.

T. E. McAvoy, of 7 West 67th St., New York City, is contractor for the steel erectors. Mr. McAvoy originated the derrick design and has applied for a patent. The derricks were detailed and the equipment furnished by John T. Horton, of 95 Liberty St., New York City.

*For an example of the erection of an armory roof by the use of tower travelers, whose frame served to support the arch sections until connected, see Eng. News, Aug. 29, 1907, pp. 220-223, on the Troop C armory in New York City.

Elevated Tank of 200,000 Gallons Capacity, St. Louis, Mo.

A large elevated tank built during the past season at the St. Louis (Mo.) Insane Asylum is shown in the half-tone view Fig. 1 herewith. The compact, clean-cut appearance of the structure makes it seem smaller than it is. The tower is 157 ft. high from ground surface to base of connection ring, and has a diagonal spread of 82 ft. c. to c. of opposite legs. The tank is 30 ft. in diameter and 34 ft. 9 ins. high at the side, with a spherical bottom 6 ft. 3 ins. deep and a conical roof 8 ft. 8 ins. high. The total height from ground to peak is a few inches over 200 ft.

The tower has four legs, set radial, but the carrying ring is not supported directly by them. Some 20 ft. below the ring each main column breaks up into three secondary columns, one of which continues in the line of the main post while the other two flare outward to the third-points of the quadrants. Thus the ring is supported at 12 points equally spaced around the circumference.

The main columns have a very stiff section, formed of two I-beams riveted over the flanges of an I-beam. A 12-in. 31½-lb. I-beam and two 18-in. 55-lb. I-beams are used, to take the maximum column stress of 500,000 lbs. direct load and 75,000 lbs. wind load. The reduced upper section (middle secondary column) continues the 12-in. I-beam but has only 9-in. 13¼-lb. cover channels. The inclined secondary columns depart from this type of section, being each two 12-in. 25-lb. channels, latticed 10 ins. back to back. The columns were designed for a compressive stress of 14,000 lbs. per sq. in. for total load, or 12,000 lbs. per sq. in. for dead load, as the length-ratio of the columns is less than 90. The stress allowed by the specifications under this condition was 16,000 lbs. per sq. in. for dead load, but the designer considered this an excessive allowance.

The tower is braced with adjustable loop rods, two 1-in. square rods being used for each bracing member of the three main panels and two ⅞-in. rods in the upper panel. The horizontal struts consist of two 7-in. channels, latticed 9 ins. b. to b., which is more than ample for the stress carried but results in a rather slender strut; they are supported at the middle by hanger rods from the intersection of the diagonals. The connections of the bracing are made by double pin-plates and 2-in. pins with gas-pipe separators; the middle connection has five pins, four for the diagonals and a central one for the attached two hangers. The tower contains no bracing in the horizontal plane.

The tank, designed for a tensile stress of 10,000 lbs. per sq. in. net, is made up of ¼-in. to 7/16-in. plates in the shell, ⅜-in. plates in the bottom, and 3/16-in. plates in the roof. The tank is stiffened by a 5 × 3 × ½-in. angle ring (5-in. leg horizontal) at the lower third-point, and a horizontal ring girder 24 ins. wide at the upper third-point. The top edge has no stiffening except what is provided by the roof and its 6 × 3½-in. attachment angle.

The segmental bottom, radius 21 ft. 3 ins., consists of 20 tapered plates about 60 ins. wide at the upper end. At the middle is a circular dished plate 3 ft. in diameter, also ⅜-in. thick. The 12-in. pipe-connection hole in the center of this plate is reinforced with a 7-in. ring of ⅜-in. plate. The tapered plates are lap-jointed to each other, being alternately inside and outside, and where they abut on the dished center-plate the inside plates have filler pieces to provide a level seat for the dished plate. At the outer periphery of the bottom, however, the plates are scarfed, thereby widening their lap to about 8 ins. for a depth of some 6 ins., taking two rows of four rivets each; this gives a smooth single thickness at the periphery for attachment to the bent-plate border ring at the bottom of the shell.

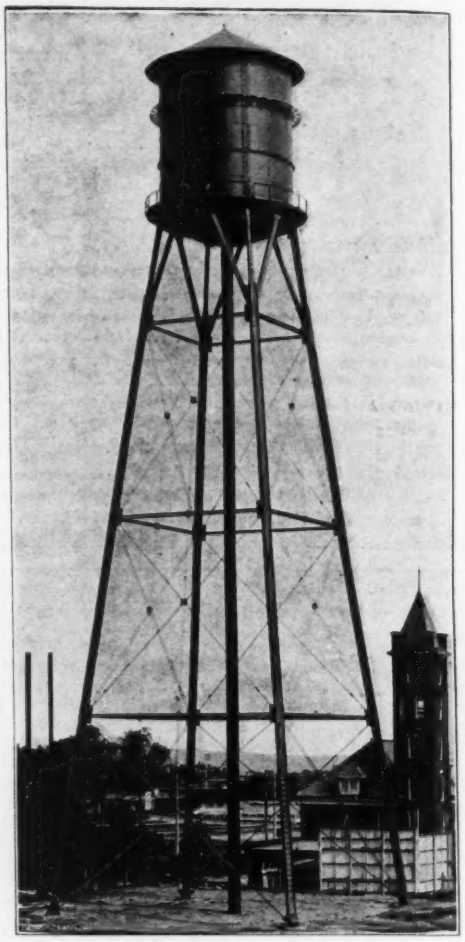
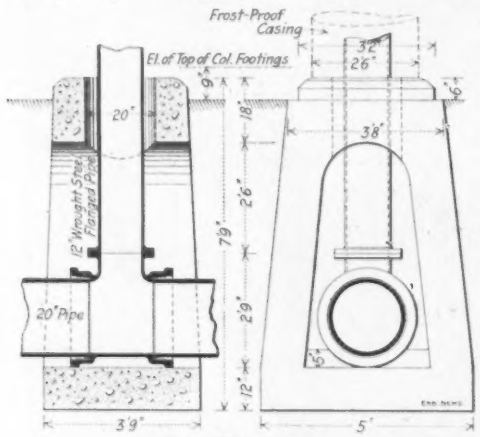
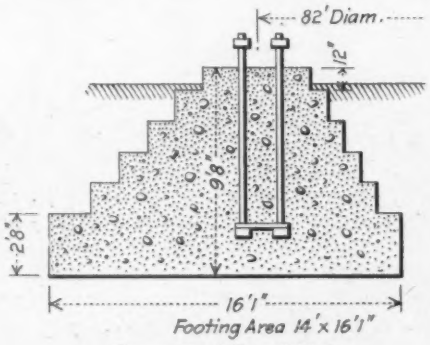


Fig. 1. Elevated Tank of 200,000 Gallons Capacity, Insane Asylum, St. Louis, Mo.



Pipe Foundation.



Tower Post Foundation.

FIG. 2. FOUNDATION DETAILS OF TANK TOWER.

The tapered plates are lap-jointed to each other, being alternately inside and outside, and where they abut on the dished center-plate the inside plates have filler pieces to provide a level seat for the dished plate. At the outer periphery of the bottom, however, the plates are scarfed, thereby widening their lap to about 8 ins. for a depth of some 6 ins., taking two rows of four rivets each; this gives a smooth single thickness at the periphery for attachment to the bent-plate border ring at the bottom of the shell.

The arrangement of the connection ring is shown in the sketch Fig. 3. The shell is seated on the top flange of a drum girder, coned slightly to correspond with the batter of the columns. At this flange the bent-plate ring is also seated. A circular platform extends around the tank at the level of this seat. This platform is supported by triangular brackets cantilevered out from the drum girder. This latter is stiffened in the plane of its bottom flange by angle ties connecting the heads of the secondary columns of each tower leg, and a web-plate riveted between this tie-angle and the flange of the conical girder.

The water pipe is 12-in. wrought-iron flanged pipe, surrounded by a lagging of three thicknesses of wood with two layers of tarpaper and air spaces. It is attached to the tank by a stuffing-box sleeve, allowing for expansion. The pipe was used as a gin-pole to erect the tower. As shown by Fig. 4, the upper section of a main column, 68 ft. long, weighing 9,500 lbs., was set in place by the help of this pipe, the latter being 135 ft. long at this time. Great care was required in handling and guying this flexible gin-pole. Mr. Flad, Consulting Engineer, writes of this work: "The use of this long pipe as gin-pole is too hazardous to be recommended."

The tower rests on four concrete piers 14 ft. × 16 ft. 1 in. at the bottom and 9 ft. 8 ins. high, proportioned for a base pressure of 3,000 lbs. per sq. ft. They were originally designed with the base inclined at right angles to the axis of

the column, but were built with horizontal base. The columns are anchored to them, although there is no uplift at the maximum wind-pressure specified (30 lbs. per sq. ft. on tank and 200 lbs. per lin. ft. on tower) even with empty tank. These bolts make the tower safe against overturning up to about double the pressure specified.

The water pipe has a concrete foundation (Fig. 2) detailed so as to leave all parts of the pipe accessible after digging away the earth.

The tower was designed by Mr. Edward Flad, of St. Louis, as Consulting Engineer to the Mississippi Valley Construction Co., who obtained the contract from the city of St. Louis, B. C. Adkins, Water Commissioner, and E. E. Wall, Deputy. The American Bridge Co. fabricated the superstructure and made the detail drawings. The contract price for the structure erected was $14,885, exclusive of foundations.

The Work of the Chemical Laboratories of the U. S. Bureau of Mines.*

By J. K. CLEMENT.†

The chemical work in the Bureau of Mines is divided among a number of separate laboratories, each carrying on its own lines of work, under the direction of its own chief; the whole forming a group of more or less independent units.

The Fuel Testing Laboratory is occupied mainly with the analysis and calorimetric testing of fuels, including coal, coke, lignite and peat. In addition to analyzing samples of all fuels used in the boiler and gas-producer tests of the Bureau, ultimate analyses and calorific value determinations are made on mine samples of coal collected by the U. S. Geological Survey, as well as by certain State Geological Surveys. The data on these latter tests are of value in establishing the composition and heating value of the coals in connection with the classification of the coal fields of the United States.

In addition to the laboratory at Pittsburg, there is located in Washington, D. C., a laboratory in which are tested samples of coal, delivered to the various buildings, arsenals, navy yards and military posts in various parts of the country, and of the coal purchased by the Panama R. R.

In the use of coal under steam boilers, the property next in importance to its calorific value is perhaps the fusibility of its ash. Indeed, some coals, which have a high heating value, are worthless for making steam on account of their tendency to clinker and adhere to the grate bars. The relation between the fusibility and clinkering properties of coal ash and its chemical and mineralogical composition is now being investigated. It is interesting to note that titanium oxide (TiO_2) was found in all the clinkers examined in amounts varying from 1% to 3%. Determinations of the fusion point of various ashes give values ranging from 1,150° to 1,400° C.

The Bureau is making a study of the commercial bodies contained in the crude petroleums of the United States, of the methods for their separation and purification and of their economic uses. The California fields, because of their showing at this time the greater promise of a large and continued production, their proximity to naval stations, and the peculiar adaptability of their product as a maritime and a locomotive fuel, have been selected for first study. Besides the determination of the properties and uses of the various products of the petroleums of the country, an investigation is being made of the processes of distillation and of the methods of refining.

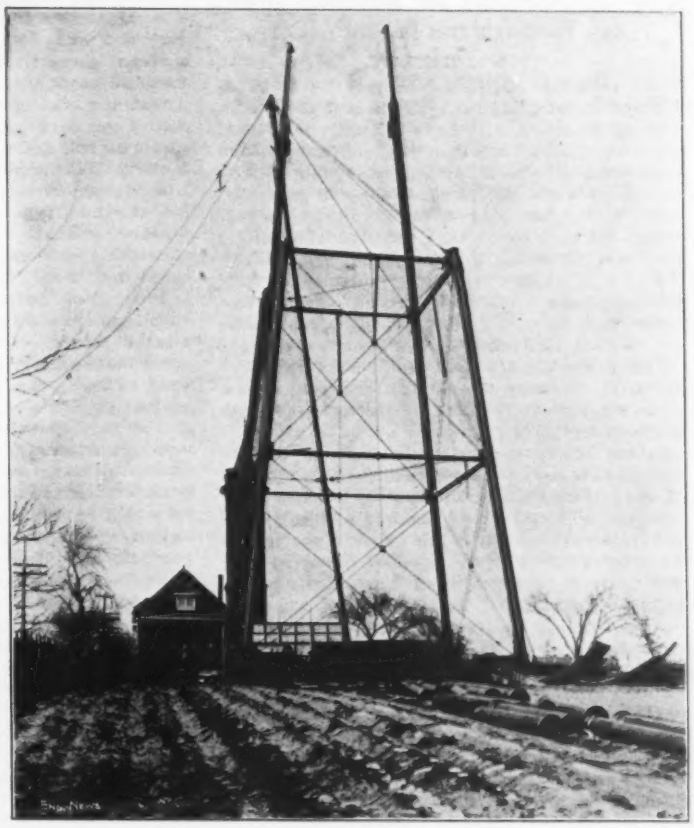


FIG. 4. VIEW DURING ERECTION OF THIRD SECTION OF TOWER LEGS, SHOWING 12-IN. PIPE 135 FT. HIGH USED AS GIN-POLE.

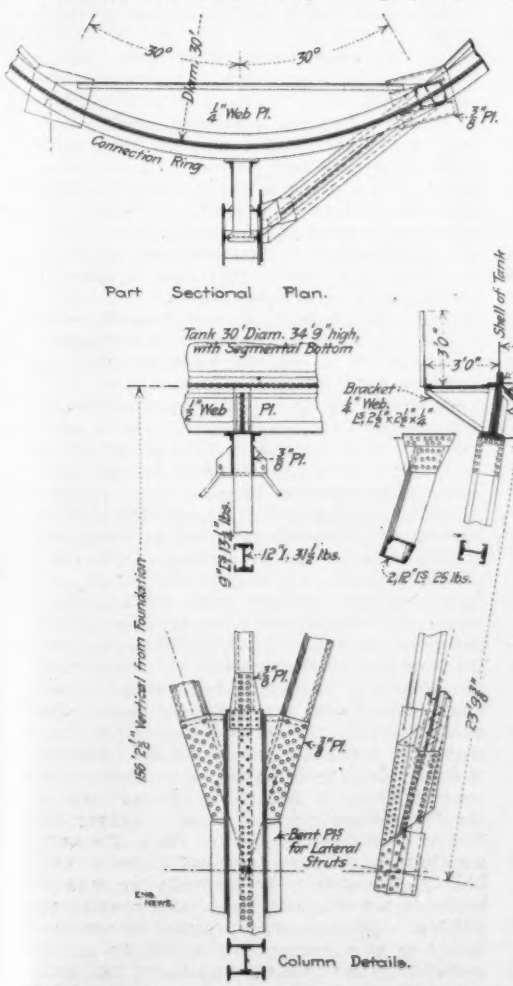


Fig. 3. Details at Top of Columns, and Connection Ring at Junction of Tank Shell and Bottom.

The processes of combustion in the boiler furnaces are being investigated in a furnace specially designed for the purpose. By taking simultaneous samples of the combustion gases, the progress of the reactions may be followed and the time or space necessary for the complete combustion of various coals, and under varying conditions of operation, may be determined.

The process of producer-gas formation is being studied from a physical chemistry standpoint, and an attempt will be made to apply on a commercial scale the results of laboratory experiments on the rate of formation of carbon monoxide and water gas.

Our scientific knowledge of the chemical character of coal is limited almost entirely to its chemical analysis and its adaptation to certain industrial operations. The object of one of the investigations of the Bureau is the isolation and identification of some of the constituents of coal. By the use of inert solvents, it has been found possible to extract as much as 35% of the original coal. A number of different substances have been isolated and the analysis and molecular weights of some of these substances have been determined. In a few cases it is believed that the materials are practically pure substances. The quantity and composition of the gases evolved from various coals, when heated to temperatures of from 400° to 1,000° C., have been determined. In the experiments which are now in progress, particular attention will be given to the influence of the rate of heating on the character of the gases produced to the initial composition of the gases at the instant of liberation, and to the thermal decomposition of these gases during passage over heated surfaces.

In cooperation with the Navy Department, the Panama Railroad Co., and the University of Michigan, the Bureau is conducting an extensive series of tests on the deterioration of various coals in storage both in the open air and when submerged in fresh and sea water.

The quantity and rate of formation of inflammable gas from freshly mined coal, at ordinary temperatures, and the rate of absorption of oxygen by the coal have been determined. The spontaneous combustion of coal is being investigated by the Bureau. Statistical information will be combined with the results obtained in the laboratory. The burning of coal in mines under a diminishing supply of oxygen and the factors governing the propagation or extinguishing of fires in mines are being investigated. Chief among these are variations in temperature and in the oxygen content of the surrounding atmosphere.

Examination is made of samples from normal mine air, from the after-damp following explosions, from stagnant areas and from burning areas during mine fires. Particular attention has been given to the detection of small amounts of carbon monoxide. By analyzing samples during the progress of mine fires, the chemist has assisted in combating fires. The effect of variations of barometric pressure on the exudation of methane and the influence of carbon dioxide on the explosibility of mine gases are being investigated.

Chemical analyses are made of all explosives submitted to the Bureau for test, of the products of combustion of explosives, and of electric detonators, blasting caps and fuses.

The two greatest sources of danger encountered in mining operations are the explosive gases given off by the coal, and the finely divided coal dust which exists throughout most coal mines. The first danger can be overcome by increasing the ventilation in the mines. Unfortunately, this increases the danger from the coal dust by the removal of its moisture. A laboratory method has been devised to test the inflammable character of samples of coal dust, and to classify them according to their inflammability. This method is based on determining the amount of combustion which takes place when clouds of dust of the same density are ignited under the same conditions; the amount of combustion being determined by the pressure developed within the explosive vessel. In this way it is possible to obtain results on any one sample of coal dust which agree to 3 or 5% of the total pressure developed.

*Abstract of paper read before the Annual Meeting of the American Chemical Society, Minneapolis, Dec. 27, 1910.

†Physicist, U. S. Bureau of Mines, Washington, D. C.

Notes On Roadways for Residence Streets and Thoroughfares In And About New York City.

The following notes, on the practice of building and maintaining roadways in and about New York City, designed to have a longer life and to give much less dust than the old water-bound macadam, are based on an examination of a considerable mileage of roadways and a conference with those responsible for the practices noted. It is believed that these practical notes will be of interest to road builders everywhere, since the problems of caring for automobile traffic while perhaps most acute in the outlying and suburban districts of a metropolis are pressing for solution throughout the civilized world.

The notes quite naturally separate into two parts; (1) those on the several boroughs of New York City, and (2) those on various suburban towns.

In the administration of the highway departments in the several boroughs comprising the City of New York, each department is practically separate in fixing its own methods of construction and maintenance, as it is held that the problem in the several boroughs are so widely different that they can best be solved by the men most familiar with local conditions. However, the several departments come together for conference with the Chief Engineer of the Bureau of Estimate and Apportionment, where, so far as is desirable, practice is standardized. This perhaps, relates more particularly to the preparation of specifications and contracts. The budget estimates which form the basis of the appropriations for future maintenance and construction are computed by each department upon its own data and experience.

Under existing conditions in New York City, it is impossible to use proprietary processes of road construction and to buy proprietary materials, as such, to be used by the departments themselves. This means that specifications for the materials, or the methods which are aimed at, must be prepared before hand and advertised for if the work is of any appreciable magnitude.

Borough of Manhattan.

In the Borough of Manhattan, comprising the district in which the business and population is most concentrated, the problems met with in the outlying boroughs and in the other cities and towns lying around New York City are not encountered. With the exception of park roads, and the very few miles of comparatively undeveloped territory, the roadways are all of what may be called a city pavement—wood or stone blocks, asphalt, etc. The traffic conditions are necessarily so severe that the types of surfacing which have been serviceable for ordinary residence streets are of no use here. At the same time, property values are so large that the income from taxes, without being burdensome, is sufficient to render economical the use of the highest types of city pavements, such as granite blocks, asphalt blocks, creosoted wood blocks and sheet asphalt.

Therefore Manhattan has been excluded from this discussion, except for certain parkways.

New York Parks.

In all the borough parks of New York City there are something over 100 miles of roads, exclusive of bridle paths, walks, etc. The automobile traffic on most of this mileage is extremely heavy, so that the old wearing surfaces have been found entirely inadequate and of such short life that even annual resurfacing in the best possible way was not sufficient. In Manhattan and Brooklyn the park roads have been made from Roa Hook gravel and clay, in order to secure the esthetic effect of a country drive, which could not be done with macadam. These roadways have not been as enduring as macadam even, but the cost has been held to be a secondary matter. To keep down dust, on these gravel-clay park drives, an emulsion of light asphaltic oil has been applied once about each ten days.

In the Bronx, however, park roads, up to the time when motor-vehicle traffic became so large, were of the ordinary type of telford macadam. The macadam was composed of crushed trap rock, sprinkled and well rolled, but with no binding material other than water and the dust in the screened stone and that formed by rolling. The screenings used in surfacing, however, were permitted to have not over 30% dust, and these under a great amount of rolling, compacted satisfactorily. Construction and maintenance in the Bronx parks has been under the supervision of Mr. Martin Schenck, Chief Engineer, and former State Engineer of New York. The following statements concerning this work have been secured from him.

About three years ago it was found that the raveling of roadways, worn down to the medium sizes of stone, was becoming so very troublesome that means must be sought to increase the bond in the surface layers. As these park roads sustain little traffic which gives sufficient impact to shatter the stone, the main idea of the studies undertaken was to increase the bond. An arrangement was made between certain asphalt pavement contractors and the Park Commission by which several thousand square yards of macadam were thoroughly resurfaced without expense to the city, in the hope of developing a lasting surface for parkways, but also a surface not having the appearance of sheet or block asphalt, as seen in the city streets, as it was felt that such roadways would be out of place as park roads and, in addition, would prove unnecessarily expensive. Several variations of surface material were tried, most of these on what is known as the Bronx and Pelham Parkway in the Borough of the Bronx.

TAR.—Where roads were worn to the medium size stone, but not so as to impair the contour, resort was had to spreading hot refined tar to a depth of about ½ in., followed immediately by a coating of fine screenings, well rolled in. The same thing was tried on another section, except that the tar mixture was allowed to cool before the screenings were applied. This latter method was approved by the contractors, but not by the engineers of the Park Commission, who believed that better results would be given with the screenings applied while the tar was still hot. Experience bore out this belief.

Where the roadways were full of pot-holes and otherwise badly deteriorated, the whole surface was scarified, cleaned and a sufficient quantity of new stone put on to bring the crowning up to its proper grade. Hot refined tar (proprietary preparation) was applied to this by hand-sprinkling, and fine stone and screenings were finally laid on, as in making what is generally known throughout the country as tar-macadam.

ASPHALT.—On part of the roadway, liquid asphalt was used instead of hot tar. This particular section was found to "bleed" for a couple of years in the hottest weather so that additional screenings were required to take up the surplus liquid asphalt. This scheme finally resulted in an improved surface which wore well and did not flow under traffic, but was soft enough to show some indentation from horses' hoofs. It was not slippery in the worst weather, but where tried there were no bad grades. The cost of this combination of liquid asphalt and broken stone, about $1.70 per sq. yd., was considered too heavy to warrant its general adoption.

What is called an "asphaltic earth" was tried on about 300 ft. of roadway at the end of the Bronx and Pelham Parkway. The trial strip was so successful that its use has been extended on the same road. This "asphaltic earth" is a good grade of coarse sand which has been mixed hot with liquid asphalt and allowed to cool. It is believed that this type of surfacing can be put down by any contractor who can secure liquid asphalt, so that it may be taken out of the class of proprietary pavements. However, the several thousand yards of this surfacing which have been laid on the Bronx and Pelham Parkway since the experiments were carried out have been laid by the contractors who made the original experiments, and naturally they are in possession of some tricks of the trade which would have to be learned by others.

Where this "asphaltic earth" is to be used at a considerable distance from the plant of the contractors, it is packed in barrels while hot and shipped to the work. The barrels are later broken open and the cold material is smashed up into lumps of any convenient size for distributing along the roadway. The road is scarified as usual and enough broken stone is put on to bring the crowning up to proper sub-grade. Before applying any of the "asphaltic earth" the stone is rolled in place dry with the common three-wheel ten-ton road roller. A tandem roller with fluted rolls, much like those used in puddling clay, rolls the cold "asphaltic earth" into the stone so as to secure a good mechanical bond. The rolling is continued until a uniform surface is secured, and the rolling can be continued to such a length that a practically smooth surface will result, which might not be expected on account of the fluted rollers on the machine.

The reduction of the lumps which are necessarily found in this use of the cold "asphaltic earth" required so much time that on a part of the Bronx and Pelham Parkway which was close by the contractor's home plant the material was transported while still warm and dumped onto the stone, being immediately rolled into place with the fluted roller.

As soon as the roller has finished with a section of this surfacing, traffic can be turned onto it without delay. The surface from any time immediately after rolling to a couple of years later (the oldest yet laid) has a fine, grainy appearance due to the particles of sand maintaining their individuality. No seal coat or asphalt appears and there is not the rubbery appearance of the city sheet-asphalt pavement. It is reported that in mid-winter this surface will indent under a horse's hoofs very nearly as much as in summer-time, and that not the slightest difficulty has been found with flowing or bleeding in the hottest of weather. The cost of this application of cold "asphaltic earth" is about 90 cts. per sq. yd., including the revamping of the old macadam and a repair guarantee of the surface for five years.

With the "asphaltic earth" surfacing, the roadway, even in winter-time, can be penetrated with a knife-blade. This same penetration test in summer does not reveal any appearance of rubber, but causes the same breaking up into chunks of parts next to the blade at the surface. One of the great advantages claimed for this type of surfacing is ease of repair. It is said that this material binds itself easily to any sort of cleaned and roughened roadway, so that in filling up pot-holes that may develop from any cause it is only necessary to pick the old surface and to dump in the cold "asphaltic earth." If the extent of the repair is not enough to need a roller, it may be hammered down into condition by hand.

On another section of this same parkway, an asphaltic concrete is being applied. The old macadam surface is being renovated and brought to proper crown and grade, as in all similar work. The asphaltic-concrete wearing surface, which is applied on top of the renewed macadam, is composed of broken stone, sand and asphaltic cement in about the proportions of 200 lbs. of asphalt to 0.5-cu. yd. of sand and 0.9-cu. yd. of ¾-in. to 1¾-in. crushed stone. The asphaltic cement is refined asphalt combined with heavy petroleum oil flux, or with liquid asphalt. Only the most general specifications are laid down for the asphalt to be used, it being stated that asphalt shall mean any natural bitumen, liquid or solid, which is adhesive, viscous, ductile or elastic, or which becomes so on the application of heat; the city is protected by demanding a guarantee bond of 20% of the contract price for the faithful maintenance of the roadway surface in good condition for five years. The aggregate is to be properly dried and heated to about 300° F. immediately before agitating with the asphaltic cement. On top of this wearing material a skin coat of the asphaltic cement is spread on at a temperature of 300° F., and immediately over this a top dressing of fine gravel or stone chips free from dust is spread and well rolled in. The small surplus stone unbound by

the asphaltic cement is to be worn in or worn away by traffic.

OILS.—While experiments with asphalt-bound surfacing have been carried to what is believed by the Engineer of the Park Commission to be a successful and acceptable point, at the same time the use of oils as a temporary binder has not been neglected. It may be said that they have been used here as a substitute for water sprinkling, and, indeed, it is claimed that water sprinkling is the most expensive form of keeping down dust in the parks. A heavy oil, 60% asphalt, has been placed directly on some macadam roadways, which were in good shape, with a "California" sprinkler after the roads had been thoroughly broomed. A half inch of sand or fine stone screenings has been applied after the oil had hardened. All this work has been done by contract with a guarantee of a year. The results have been considered satisfactory for those roads where the traffic is not so heavy that a bituminous-bound road becomes advisable.

On roads which showed signs of rapid disintegration, where there was the heaviest of automobile traffic, such as on the Bronx and Pelham Parkway, emulsions of rich asphaltic oils have been applied to prevent raveling before it was possible to undertake the resurfacing. In such cases the oil emulsion has been applied to one-half the width of the parkway at a time. The roadways on examination are seen to have the medium-sized stone exposed to wear, but yet well bound down. There are no bad grades where this work has been carried on.

Emulsions of various light road oils have been used on a few roads without preliminary sweeping. Here the idea has been merely to hold together some of the excessive traffic cushion which collected. It was expected that such applications of light emulsions would be good for a month, but often they have failed to serve for more than a couple of weeks. A few pieces of park road have been made of Hudson River gravel, laid down with a heavy emulsion of asphaltic oil and well rolled into place. These have given good service for a single season, but no great strength of bond in the wearing surface was expected or has been obtained.

Borough of Brooklyn.

While most readers are apt to regard the Borough of Brooklyn as a typical city, with characteristic high buildings and closely built-up areas, yet after a distance of some three or four miles from Borough Hall southward has been covered the aspect of the borough changes to that of the regular outlying suburban town; the buildings, off the business thoroughfares, are surrounded by larger or smaller lawns and the buildings themselves conform to a town, rather than a city, architecture.

In Brooklyn Borough there are approximately 1,000 miles of traveled streets, of which about 380 are in what we may call the suburban section. Of these streets approximately 300 miles are unimproved dirt roadways and 80 are macadamized, either ordinary or bituminous-bound. Only 90 miles of these dirt roadways are legally open (title to the land in the street vested in the city). Private streets do not receive any attention from the city and hence usually are in a deplorable condition. On account of limited appropriations, the dirt roadways under city jurisdiction are cleaned up only once or twice a year and are therefore sometimes not much better than the private roads. Unimproved roadways are being paved at the rate of about ten miles per year. On these dirt roads, after a period of drought, the soil pulverizes to a depth of 6 or 8 ins. so that the ordinary delivery teams, moving even with proverbial slowness, envelop themselves and the street in a cloud of stifling dust.

OILS.—Light asphaltic oils (40%) have been used on some dirt roads to hold the surface in place. They have been sprinkled on after the road was brought to approved shape and left to be absorbed as best the nature of the road permitted. The natural earth in the eastern part of the borough seems to be a sort of fine sand, held together by a small amount of some colloidal matter like clay. Under the traffic of teams with narrow tires on unimproved roadways the oil-bound earth has become more or less of a greasy meal, but the great advantage of comparative dustlessness has been secured. For a contrast it is only necessary to walk from one of the oiled-dirt streets to one of the untreated private roads to realize the improvement in the comfort of the residents. Here, therefore, it is a question of balancing the disagreeableness of the first few days after the application of the oil to the greatly increased freedom from dust under necessary traffic.

The Highway Department feels that considerable success has been secured in prolonging the life of macadam and in keeping down dust by surface treatment with 50% asphaltic oil once a season. The macadam to which this oil has been applied has been fairly new and in good condition. After a thorough brooming the oil has been sprinkled on, brushed in and left to dry for three or four days. After this, ¼-in. of coarse sand has been sprinkled on. Where crushed rock screenings have been used, instead of the coarse sand applied on top of the crude oil, shorter life and poorer appearance have resulted.

A 40% asphaltic oil has been used on some macadam roads without brooming away other than the lighter litter. Such oil has served to keep the road in fairly dustless condition and to hold the traffic cushion together and in this way to prevent excessive wear on the metal of the road itself. There has been no trouble from slime in wet weather when the work was done after Spring settling.

ASPHALT.—The old macadam, up to three years ago, received no treatment to ensure longer life or to reduce dust. Finally it was found that they required annual resurfacing, where the traffic was heavy, and then the new surface scarcely lasted through the season. By binding the new "metal" together, or by surface treatment to hold down dust which formerly was thrown into the air, as the needs of each case develop, the life of macadam roads has been increased in this borough variously up to about five years before resurfacing has been found necessary. The longest life has been secured with an asphalt-bound pavement. In laying this, the coarser trap rock needed to bring the grade and crowning up to the proper points is rolled down thoroughly, then simmering fluxed asphalt is sprinkled on and the natural voids are filled by brushing in smaller sizes of crushed rock. A further application of the hot asphalt, followed by the screenings, or sand, has been used to complete the wearing surface. Such a reconstruction of the top of a macadam road has been done at approximately 75 cts. per sq. yd.

TAR.—Some tar-macadam has been laid down as the old macadam has needed repairing. Proprietary preparations of tar binder have been used, and at the time these pieces of tar-macadam were put down the heavier grades of binder were not available. In such roadways soft spots and pot-holes developed after two or three years use, and they are attributed by Mr. H. H. Schmidt, Acting Chief Engineer of the Department of Highways, to an improper filling of the voids in the larger sizes of rock.

The improved roadways in this borough are regularly cleaned by a branch of the Street Cleaning Department, which is independent of the borough Highways Department. Therefore, on macadam roads, here one would expect that dustlessness and freedom from litter would prevail. However, in the outlying districts the street cleaning does not seem to be carried on in the same way as in the districts closer to the center. The borough is divided up into inspection districts, and on the reports from these inspectors the orders for maintenance and repairs are made up. No routine of oiling the various roads is followed beyond that of doing the work as soon as possible after the inspectors' reports of necessity.

Borough of Richmond.

The Borough of Richmond presents a study of all sorts of road pavements, from the strictly country type of dirt road to the permanent business-street paving seen in the fully developed sections of the city. This borough, being separated from metropolitan New York by a long stretch of water, takes on the characteristics of large towns or a small residential city, so that the problems met here are typical of those considered in this article. Automobile traffic on a few roads across the borough is very heavy from machines passing to and from the Borough of Manhattan, as the Island forms a convenient route for long cross-country runs, it being merely necessary to take the Municipal Ferry from Battery Park.

There are something over a hundred miles of turnpiked country roads. These are not heavily traveled, but as soon as the traffic on them increases so that ordinary maintenance is not sufficient to keep them in easily passable condition, some more permanent roadway is constructed. In the care of these roads the ordinary ruts are filled in as they develop and the whole roadway is shaped up two or three times a year, as seems necessary. The roads are regularly inspected so that the need of immediate repairs on any portion is learned soon after trouble develops and there is small liability of not keeping the roads up to standard.

There are approximately 175 miles of macadam roadways, some of which are built on a heavy telford base, in addition to about 25 miles of bituminous-treated macadam, these stretches being in places where it has been found that the wear of the ordinary macadam was too rapid to permit the maintenance of a satisfactory street. Three methods of treating and building this special macadam are followed, which are discussed later. There are also about 30 miles of so-called "permanent" sheet and block pavements. The work of building, maintaining and cleaning the streets is under the general jurisdiction of the Borough President and under the immediate supervision of the Commissioner of Public Works, Mr. L. L. Tribus, M. Am. Soc. C. E. is Consulting Engineer and Acting Commissioner, and under his guidance the practice noted herein has been developed, the work of original construction being carried on by Mr. T. S. Oxholm, M. Am. Soc. C. E., Engineer-in-Charge, and of repair and maintenance by the Superintendent of Highways, Mr. Horace E. Buel, who has done much towards the success of the bituminous treatment.

For handling the several branches of the public work, the borough is divided into inspection districts. The inspector for each division of work in each district has under him a number of foremen. The inspectors of each division report to the superintendent of the bureau handling such work, and these superintendents report to the Consulting Engineer and Acting Commissioner. Progress is thus followed at headquarters and authority and advice are obtained daily, as needed. In this semi-military organization, every attempt has been made to place specific responsibility upon each man.

The street cleaning under the supervision of Mr. J. T. Featherston, M. Am. Soc. C. E., which has much to do with the condition of the roadways as regards dustlessness, is carried on with a view to removing the inevitable litter from the roadways as soon as it accumulates. In some parts of the borough, this necessitates two cleanings a day, and in others only, perhaps, two cleanings a week. Street cleaning, of course, is attempted only on those roadways which may be called improved streets, but here the standard is very high.

The street cleaners themselves form a repair corps, for on rainy days when it is not practicable for them to do cleaning, they don their oilskins and with a hand-barrow loaded with stone, screenings and tools they make the minor repairs to the macadam roads in their district. This is considered a measure of great economy, as small repairs are made as soon as trouble develops, which, if neglected until a regular repair gang could make its appearance, would mean a much heavier yardage to restore the roadway. When, in spite of these slight repairs, the roadway demands greater attention, it is reported to the Highway Superintendent to institute radical repair or reconstruction.

OILS.—Three years ago, oiling was commenced on one of the more traveled macadam roads having a heavy telford base. On different lengths of the road, different asphaltic compounds were spread after cleaning. The oil was sprinkled on from an ordinary sprinkling cart, and sand, grits, or screenings were spread down to absorb the excess of compound. This treatment was satisfactory in reducing dust for the season during which it was applied, but there was little permanent effect of binding the metal of the road together sufficiently to withstand the stresses imposed by heavy automobiles. In only one or two instances has a pavement so oiled been found to have a traffic cushion which churned up into a slimy mud during a rain. This persisted for a few hours after the rain had ceased, but the traffic cushion soon dried out and was soon ironed to its usual condition. It is believed here that this action of rain has no single cause, but is rather the result of an unfortunate combination of conditions. That is, the quality of the oil (the presence of more or less paraffine constituents) has something to do with the result and the condition of the road has still more. If the stone in the road should not happen to be sufficiently dry, as in the case of heavily shaded spots, and if too much oil is applied, it is believed that the trouble will be encountered. Where every attempt is made to prevent the combination of these conditions, it is believed that no trouble will be met with. Weather conditions have to be very carefully considered, both those before and during the operation, and the skill of the workmen in doing this particular work has much to do with the lasting success of the results.

Two years ago some sections of these heavily traveled macadam roads were resurfaced with an 85% asphaltic oil. The road was scarified and the surface rock was cleaned and relaid with sufficient new stone to bring the road up to proper grade and crown. The oil was then applied by a combination heater and sprinkler. This oil was received in tank cars and had to be warmed with live steam before being run into the sprinklers. The heating attachments were necessary to keep the oil sufficiently flowing. This treated stone was rolled after oiling, grits being sprinkled on in front of the roller in order to prevent gumming up the wheels. This type of road proved satisfactory and has given promise of lasting several years before much resurfacing will be necessary. In a very few spots, where too much of the asphaltic oil was applied, there has been a slight tendency to ooze, but this has been corrected by the addition of sand and grits.

ASPHALT.—The third type of construction is that variously known as asphaltic macadam or bituminous concrete. The road is scarified, if a reconstruction job, and sufficient new stone is laid to bring to sub grade, ready for the wearing coat. This surfacing, or wearing coat, consists of about 3 ins. of a prepared mixture of tar, or asphalt, and crushed stone, properly selected so that the voids are filled. This is delivered hot at the place of laying and is rolled in place. Some roads of this character have been down four years in this borough and on grades up to 6% without the necessity of any repairs whatever within this time.

The cost of cleaning a macadam surface and applying the lighter road oil, first mentioned as a strictly surface treatment, has been found to be from 4 to 6½ cts. per sq. yd. Where the stone is scarified, cleaned and sprinkled with the heavier asphaltic mixture and rolled, the cost runs up to about 67 cts. The reconstructiond of a macadam road with a pre-mixed material for a 3-in. wearing surface increases the cost still further from $1.50 to $1.70 per sq. yd.

In this borough, as in suburbs generally, it is found that the heavy traffic upon the principal business thoroughfares is largely confined to a narrow path, so that, in general, the more satisfactory solution is the employment of a more permanent stone, brick or asphalt block pavements; but in a few instances, it has been found that the bituminous-concrete surface, before described, has stood the traffic for as many as four years without need of repairs. These cases have been where very considerable, though short, grades prevailed so that the heavy trucks which were hauled over the pavement did not stand in one place for any appreciable length of time. This has removed the chance of horses pawing loose the surface material, which is believed, in this borough, to be a cause for rapid deterioration of such surfaces on business streets.

MACADAM.—The common macadam is usually laid with such binding as is effected by rolling and wetting. In some cases, however, a moderate amount of sand and grits (Cow Bay sand screenings from about ¼-in. down) is applied sparingly to assist the binding. Little or no clay has been applied in the construction of any macadam roads in this borough.

GUTTERS.—All residential streets are laid with a paved surface from gutter to gutter. Most gutters are of vitrified brick, laid on a concrete foundation. Asphalt block gutters have been tried, but their use has not been satisfactory except where the grade and location were sufficient, so that there was no chance of the accumulation of wet leaves or water which rotted out the asphalt binder in the blocks. The experiment was tried, also, of paving from curb to curb with the bituminous concrete, the paving material taking the place of gutters, but while no bad results followed it is not believed to be good practice.

Borough of The Bronx.

The Borough of the Bronx also shows every variety of road pavement. Under the jurisdiction of the Department of Public Works and its Bureau of Highways, there are some 700 miles of roads and streets, of which approximately 150 are of macadam and 75 of the so-called permanent, or city block type. This borough, like Brooklyn, being more closely joined with metropolitan New York by rapid-transit facilities than are Richmond or Queens, takes on quite the regular metropolitan aspect in parts, but as the purely business districts are left the buildings have the architecture and arrangement of a suburban district.

The street cleaning in this borough is done by a branch of the Street Cleaning Department, but it cleans only the so-called permanent pavements, and does not concern itself in any way with macadam, which is the only type of improved pavement, outside of block or sheet city types. Cleaning is attempted only in the more thickly settled residential districts, some of the long stretches of macadam being little more than country roads or automobile thoroughfares.

The macadam laid down here is sprinkled as rolled to assist in binding the metal together. No other binder, like clay or sand, has been used, with the exception of placing a very light coat of screenings as a top coat, which are wetted and rolled as the other.

TAR.—Surface treatment of macadam has been extensively used in this borough with the idea of keeping down the dust and of affording a temporary binder for the upper layers of the macadam. A light proprietary preparation of tar has been sprinkled on in many cases and followed with a ½-in. coat of screenings. This has been found to give a fairly satisfactory traffic cushion, not easily displaced by automobiles and heavy horse-drawn traffic. It has not proved exactly dustless, and seems to last for only a season.

OILS.—Many residential streets have been sprinkled with a 50% asphaltic oil, cold application. In most cases this has been applied in quantities of about ¼-gal. per sq. yd., being distributed from an ordinary sprinkling wagon. This quantity is so small that no brushing is needed after sprinkling to prevent the accumulation of oil in pools. This treatment is applied to one-half of the road at a time, traffic being thrown to the other side for four or five days while the oil is penetrating the macadam and hardening. Previous to the sprinkling, the roadways are swept with a horse-drawn sweeper, which is followed by hand-brooms. In this way it is claimed that all dust, loose dirt and litter is removed before any oil is applied. It has become the practice in this borough to make these applications only in the months of June, July and August, as the dampness in the spring and the chilly nights in the fall have been found to limit the penetration of the oil into the pavement. Under normal conditions this penetration has been found to be as much as 1½ ins.

About ½ gal. of oil per sq. yd. of macadam is required each year, it being applied, as noted, in ¼-gal. treatments wherever possible. No screenings, sand or other form of broken stone is placed on the oil at any time. In this way the production of slime and mud during and after rains is claimed to have been entirely prevented. The cost of such maintenance at the present time is very close to 3½ cts. per sq. yd. per yr.

EXPERIMENTAL STRIPS.—The Assistant Commissioner of Public Works, Mr. W. H. Connell, after a study of different methods of building bituminous-bound macadam about the country, instituted a series of test strips on one of the borough thoroughfares known as the White Plains Road. Construction of these strips was started in the summer of 1909 and completed by fall, supervision of the work being under Mr. Connell assisted by Mr. R. A. MacGregor, Assistant Engineer, Bureau of Highways. These strips consist of 18 sections, between Boston Road and Burke St., ranging from 150 to 350 ft. in length. There are no cross streets on this seretch so that all sections will be subjected to the same amount of traffic.

The binders used are prepared in accordance with various specifications for asphalt, tar and mixtures of asphalt and tar, the object being to find the character of binder that would give best service for a bituminous-macadam pavement. Not every variety of known binder has been tried, the 18 sections being taken to represent those with which the greatest success has actually been shown in different parts of the country. Accurate cost data of the construction of the various strips are being kept, and cost data of maintenance will be accumulated. A census of traffic will be taken and the results of the whole investigation are to be submitted to the Special Committee of the American Society of Civil Engineers on Bituminous Materials for Road Construction. The following paragraphs show in brief the construction of the different sections.

Section 1, 325 ft. long, is a bituminous macadam resting on a 4-in. concrete foundation, hot paving gravel, sand and binder being mixed at the asphalt plant of the company laying the pavement.

Section 2, 325 ft. long, was laid under borough supervision. A 2-in. wearing surface of ¾-in. stone and asphalt binder was laid on a 4-in. foundation of 1½-in. stone. Sand and stone were heated and the mixing was done at an asphalt plant.

Section 3, 150 ft. long, laid under the same supervision, consists of a 2-in, wearing surface on a 4-in. concrete foundation. Sand and stone were heated and mixed with an asphalt binder at a contractor's asphalt plant.

Section 4, 325 ft. long, was laid on a 4-in. foundation of broken stone. The wearing surface is 2½ ins. thick, composed of ¾-in. stone, chips and sand heated and hand mixed on a board platform with one company's special asphalt binder.

Section 5, 325 ft. long, is laid on a foundation of broken stone, 4 ins. thick, having a wearing surface of 2½ ins. The stone for the wearing surface was mixed cold in a concrete mixer with a heated asphalt binder furnished by one company.

Section 6, 300 ft. long, having a foundation of 4 ins. of broken stone, and a wearing surface of 2½ ins. of a proprietary pavement mixed at the plant, shipped to the work and laid cold.

Section 7, about 300 ft. long, having a foundation of 4 ins. of broken stone and a wearing surface of about 2 ins. of a cold "asphaltic earth" similar to that used on the Bronx and Pelham Parkway noted before.

Section 8, 200 ft. long, consists of 4 ins. of broken stone foundation and a 2-in. wearing course of ¾-in. stone and chips, mixed hot with a heated proprietary preparation of tar, mixing being by hand on a board platform.

Section 9, 200 ft. long, having the usual founda-

tion of 4 ins. of broken stone and a wearing surface 2½ ins. in thickness, was laid under borough supervision. Three different mixtures of tar and asphalt were used as binders on different parts of the section. The mixing was done by hand on a board platform.

Section 10, 350 ft. long, has a foundation of 4 ins. of broken stone and 2½ ins. of wearing surface, the latter being a hot mixture of ¾-in. stone, chips and tar binder conforming to the specifications of the U. S. Office of Public Roads and laid under the supervision of that office. Mixing was done by hand on a board platform.

Section 11, 100 ft. long, has a 4-in. broken-stone foundation and a 2½-in. wearing course of ¾-in. stone, sand and tar built by the penetration method under the direction of the company laying the pavement. Three applications of the binder (a proprietary mixture) were made.

Section 12, about 200 ft. long, is an asphalt-macadam made by the penetration method. On a foundation of 4 ins. of 1½-in. stone and screenings were laid 2½ ins. of 1½-in. stone spread, rolled and followed by asphalt binder; ¾-in. stone was then spread, while the binder was hot. The pavement was rolled, and a surface coating of binder, followed with screenings, was applied.

Section 13, 200 ft. long, is a broken-stone pavement 6 ins. in thickness, made by grouting with Portland-cement grout.

Section 14, 200 ft. long, is an ordinary water-bound macadam built in accordance with the borough specifications and put down for comparison with the other sections.

Section 15, 150 ft. long, consists of 6 ins. of 1½-in. stone, on which is poured hot tar, a proprietary mixture, given a surface coating of binder and screenings.

Section 16, 150 ft. long, is similar to the preceding section, except that an asphalt binder is used in place of tar.

Section 17, 159 ft. long, consists of 6 ins. of broken stone pavement, over which has been poured asphalt binder from a petroleum refining company with a surface coat followed by screenings.

Section 18, is an old macadam roadway given a surface treatment with sand and an oil binder.

While none of these pavements has been completed long enough to allow comparison of anything more than surface appearance, yet it is evident that Section 18, with the sand and oil binder, is not of practical benefit in this place, on account of too much heavy freighting with steel-tired vehicles. Hand mixing on a board platform has been mentioned in several places. This was resorted to after the failure of a portable mixing plant which was to have been used. It is expected that if any of these roadways prove desirable, mechanical mixers can be perfected to bring the cost of mixing down so low that there will be little advantage in using the penetration method over the pre-mixing. All the sections noted were rolled to suit the requirements of the representatives of different interests constructing each section.

Borough of Queens.

The Borough of Queens comprises that part of Long Island within the boundaries of Greater New York, except what is included in the Borough of Brooklyn, lying to the southwest of Queens Borough and close to Manhattan. One small part of Queens Borough lies close to Manhattan at about 30th St. and above. It stretches back into the country to include the suburban districts of Flushing, Jamaica, etc. The character of the roads and streets is seen by a comparison of mileage; there are 501 miles of dirt roads, 345 miles of macadam (19 of which is laid with bituminous binder) and about 50 miles of block paving.

TAR.—The macadam is laid on main arteries of travel from Manhattan to different parts of Long Island, and on some of these streets the number of vehicles per hour will rise to as high as 3,000 and over. The average hourly travel on such thoroughfares varies up to 470 vehicles. The macadam which formerly was put down was of the ordinary variety, wetted and rolled. Attempts were made to lay a dry macadam with sand binder, but the roadways did not prove successful. At present new macadam is being laid with a foundation course of about 4 ins. of broken stone and screenings to fill the voids. This is rolled in the usual way and covered with 1 or 1½ ins. of broken stone which is scattered with a hot preparation of tar. Three-quarter inch stone and screenings are then brushed in to fill voids between the stone and binder. It is claimed by the inspectors of the Bureau of Highways that this shallow penetration of binder is more satisfactory than where the penetration is carried through the foundation course, unless pains are taken to fill all the natural voids in the foundation stone with smaller sizes—an unwarranted expense. The wearing surface thus provided gives excellent service for a year, but at the end of that time, to preserve the metal in the road, it is necessary to apply another inch of broken stone and soak it with hot-tar preparation. The old-style macadam in this borough cost about $1.10 to lay. With the present increase in price of stone and change in hours of labor, the cost is estimated to have increased to $1.30. Where the upper layer is given a penetration coat of tar, the cost per yard amounts to about $1.45. The annual re-surfacing, which should be done on the main arteries of traffic, would cost about 15 cts. per sq. yd.

OILS.—On the side streets, and on some less traveled main thoroughfares, the macadam has been treated with a light preparation of asphaltic oil to keep down the dust and to assist in binding the metal of the wearing course. Two methods have been used in the application of the oil. In some places the road has been well cleaned and the oil sprinkled on in amounts of about ½-gal. per sq. yd. This has been followed by a layer of screenings or sand placed immediately. The second method tried has been the mere sprinkling of oil on the uncleaned macadam. The former method is generally found preferable in keeping down dust and in holding the road together under moderate traffic. Unless an excess amount of oil and screenings has been applied, little trouble has been experienced with the churning up of the traffic cushion to an oily mud at the time of rain. The road oil applied is furnished by competitive bidding in accordance with specifications prepared by the Bureau of Highways.

CLEANING.—The street cleaning for the city-type pavements is done by a bureau of the borough. This does not do any work on macadam, which is cleaned and maintained entirely by the Bureau of Highways. On account of the excessive mileage, little can be done beyond an occasional cleaning of litter from the roadways in the more thickly settled districts. On the outlying macadam roads the traffic and rains work the litter to the gutters so that only an occasional cleaning of the gutters is found necessary. The street cleaners themselves do no repairing, but they are instructed to report any troubles which are unreported by others. The macadam roads are regularly inspected by a repair gang which is given a certain amount of ground to cover each week. This mileage is covered regularly and as soon as the end of the territory assigned is reached the gang returns to the starting point and commences its following tour of inspection and repair.

CONCRETE.—A short stretch of macadam was constructed a few years ago bound with Portland cement grout. This was found to be extremely hard and even under moderate traffic easily broken up. It was not considered desirable to experiment further with the surface grouted to the foundation courses.

II. Suburban Towns and Cities.

No attempt has been made to present a complete summary of practice in the suburbs of New York City. Many of the smaller places to the north of the metropolis have not developed their own practice in the construction and maintenance of such public works but depend on a County Engineer for design and on contractors for construction. We have necessarily limited our enquiry to two of the most important and best-known of the New Jersey residential places and to two more in Connecticut.

Montclair, N. J.

The town of Montclair, N. J., has a population of about 22,000 and an area of some 27 sq. mi., with approximately forty miles of streets, nearly all of which are now macadamized. The streets for some ten years have been under the supervision of Mr. Malcolm H. Smith, Superintendent of Roads and Sewers.

The annual expenditure on streets here has risen from $15,000 to $40,000 in ten years, but the number of important streets has doubled, and the traffic on the older streets alone has practically tripled in that time. The funds for these streets are entirely derived from taxation, partly through long-established custom and partly because the life of the best surfacing that can be justified on these streets is so limited (believed to be not over eight years) that it is not regarded as permanent expenditure to be covered by bonds. No assessment can be levied, under the present ordinances, on property owners for the first macadam or for the telford base.

There are in service in this town two general classes of broken-stone roadways, not considering the heavy Telford base which they may or may not have in the various cases: (1) those with a tar binder and (2) those with a "clay" binder. There are also a few streets having a clay-bound bottom and a tar-bound surface. All three of these types have been found successful within certain limitations, and while several miles of tar-bound macadam surface are being laid each year, there is a strong belief in the efficacy and economy of the "clay"-bound Telford roadbed *as put down in Montclair.*

TAR.—The tar-macadam roads constructed from two to five years ago consisted first of a 3-in. layer of 1¾-in. trap rock, laid on a properly crowned Telford base. This was rolled with a 10-ton roller of the ordinary type and simmering tar was liberally sprinkled over the stone. Next, ¾-in. crushed rock was sprinkled on and swept into the interstices of the 1¾-in. rock with a stiff reed broom. This in turn was rolled and given a light coating of the simmering tar. A final layer of screenings was rolled in place to form the smooth wearing surface. On these older roads the macadam was 16 ft. wide. In most cases an ordinary dirt shoulder finished the street from the stone to the gutters, which were unpaved for the most part.

These roadways were not wholly satisfactory, in three ways: (1) the surface was complained of as being slippery for horses; (2) it tended to form ridges under continuous automobile travel; (3) the dirt sidings easily wore out of place if there was much travel on the side of the road and they washed away with the heavy and quick-run-off of this hillside locality. The first and third of these troubles need no comment. The second is believed by all responsible for the work in Montclair to be primarily due to a varying composition of the tar binder, to moisture in the screenings or to unrecognized conditions modifying the tar binder and making a plastic instead of a hard mass. Whatever the real cause, the effect of the automobile tires was to roll up these slightly plastic ridges and patches often, though not always, to the detriment of the area between spots.

Repairs on this kind of road are made several times a year as the worn spots develop. Crushed rock about 1-in. size is spread in the holes, after cleaning them of mud and litter, until the surface grade is restored. Then a hot tar preparation (about 300° F.) is sprinkled on liberally and screenings are brushed in immediately. The whole repair is then rolled with a 7-ton tandem roller. This repair has been found to secure a good bond between the old roadway and the patch.

This construction is being modified on grades to provide a better foothold for horses. The 1¾-in. rock is rolled and tarred in place as before. The ¾-in. stone is brushed in and tarred as described, but in place of the screening a light coat of ½-in. stone is spread before the final rolling. This roadway has stood the maximum of heavy teaming and automobile traffic on grades and curves for five years without repair. At the end of that period there are found signs of local

disintegration and sometimes extended raveling, but the roadway is placed in good order by restoring the contour with ¾-in. rock, tarred in place covered with a light layer of screenings, and rolled with the tandem roller. This repair can be made for 15 to 20 cts. per sq. yd.; the original Telford roadway costs some 85 cts. per sq. yd. This gives a good-looking and well-finished roadway and certainly its better wearing qualities on heavy grades results in a better appearance after use, than if screening were used.

An attempt is being made to induce property owners to pay the cost of completing the stone roadway, from the 16-ft. width, built by the town appropriation, out to the gutter and of paving the gutter. This, it is believed here, will increase the life of the entire roadway through removing the soft shoulder, and will decrease dust and expense of maintenance and dust laying. It is worth noting here that the gutter paving follows the street-section contour from the macadam to the curb line.

CLAY FILLER.—It has been stated that the Street Superintendent in Montclair has been favorably inclined to a clay-bound macadam, provided it is built in a particular way. The idea here has been to secure an impervious pavement from the first, whereas in some other places the binder is permitted to wash largely to the heavy stone bottom. In building this type of road the under bed is prepared as for ordinary Telford or for the tar macadam described. The 2-in. stone is spread evenly and wetted down. Previous to rolling, a yellow mealy "clay" is scattered, a quart or more to a square yard. This clay seems to be largely composed of a very fine sand containing just enough colloidal material to bind it together with great strength when dry but not enough for it to become slippery when wet. On this bed, is spread a layer of ¾-in. wetted stone, having sufficient clay scattered with it to make a surface. After rolling this smaller stone into place, with its binder, screenings are rolled on as a wearing surface. The oiling done to keep down dust on this road also helps to preserve the roadway and some of these streets in Montclair at first glance would be taken for tar macadam, so firmly is the "metal" bonded and covered with an asphaltic mat. Repairs are fairly easy; bad spots which may develop can be picked loose and wetted stone rolled in with the proper amount of clay binder.

OILS.—There are 70 miles of these roadways in this town to be kept free from dust, if such a thing were possible with present appropriations. The old remedy was sprinkling with water and this is used still where traffic is very heavy. On the clay-bound macadam various emulsions of 25 to 50% asphaltic oil have been tried with good results, both as to laying dust and improving the roadway. The routine of street maintenance is planned so that streets on which oil is used shall receive a coat about once in 20 to 30 days. Each application is from 0.3 to 0.5 gal. as nearly as can be judged.

Workmen under the supervision of the street superintendent are prohibited from using oil on any tar-bound roadway. The oil has been found to disintegrate the tar so that the bond is loosened, and the roadway crumbles, wears and washes far more rapidly than under traffic. Where the tarred macadam is not sufficiently dustless, as, for instance, when a traffic cushion is desired to lie upon the pavement, the common street sprinklers have to make frequent trips at present. It is proposed to scatter some deliquescent salt on the surface to act as a temporary binder. It is hoped that this will gather moisture enough from the dew to keep down the dust except for a brief period in the middle of the day in midsummer. This scheme has not actually been tried as yet.

The statement has been made that oil is prohibited from use on tarred macadam as a dust layer. The single possible exception is found in the use of oil on the dirt shoulders between the 16-ft. stone roadbed of streets and the curb line. It has been found effective here in holding the shoulder in place and in limiting flying dirt and litter.

CLEANING.—Most of the clay-bound and tar-macadam roads are found to be self cleaning of the more objectionable litter. This lighter material, which would furnish the dust infection, is washed to the gutters and flushed along by rains. In the event of long-continued drought it is found necessary to remove the excessive accumulations of litter by hand sweeping where complaint dictates.

BLOOMFIELD AVE.—Montclair has one business thoroughfare on which all surfacings have been failures. This is Bloomfield Ave., a county road passing through the center of the town. On it are the principal stores, shops and markets. A double-track interurban electric railway, over which some 400 heavy double-truck cars pass each day, occupies the center of the street, forcing the heavy automobile and horse-drawn traffic to narrow limits on either side. The vehicular traffic up and down this street is that produced by the passage of some 2,000 to 3,000 horses per day and of some 700 to 1,000 pleasure automobiles, motor trucks, etc. It is at once seen that this heavy traffic exceeds anything which the roadbeds of residential streets have been able to long withstand and, with the popular demand for dustlessness, seems to make a true city pavement imperative.

Many years ago a telford macadam was laid. As this road is under the jurisdiction of county officers, the town has been allowed to sprinkle or clean only with permission of the Board of County Freeholders. The board being averse to having the litter and light dirt removed, which might serve as a wearing surface to protect the stone of the macadam the street was usually either very muddy or very dusty and to the general public proved a rank nuisance. Two years ago, after much public protest, the top or macadam layer of stone was removed by the town; the stone was screened, filled with a tar binder and rolled back into place with a surface coat of new ¾-in. stone. This was satisfactory for a short time only. The litter and powdered stone still accumulated, under the maintenance rules of the county officers. As all heavy traffic was concentrated upon a practically "beaten path," and as there was no way to insist upon or to encourage driving all over the roadway, the tar-bound roadway cut into ruts, wore away rapidly although the portions for 2 ft. just adjacent to the street-railway Belgian-block paving and next to the gutters remained in good condition.

Late in 1910 the old tarred stone was removed by the County from one-half the street and replaced to a depth of about 5 ins. with clean 2-in. rock, to which was applied fluxed asphalt heated to about 400° temperature. A coat of ¾-in. stone was immediately brushed in to fill around the larger stone and the pavement then rolled. A second light application of hot asphalt was followed by ½-in. stone for a final rolling. This binder set quicker than tar and gave a harder pavement. Rolling is done with a 7-ton tandem steam roller, but a 10-ton machine has been tried for rolling down a few high edges. The roadway sets so hard, by the time the smaller roller has finished, that the heavy machine makes no impression on it. It is hoped that, with the use of asphalt binder to secure a harder roadway, the wearing qualities can be improved over the old tarred macadam. This road cannot be regarded as much more than an experiment and to further compare similar construction under the same heavy traffic a stretch of 1,800 ft. was laid one-third all asphalt-bound, one-third all tar and one-third tar bottom and asphalt top. No fine stone screenings were used on the top surface, so that a fairly rough pavement may afford a good foothold for horses. To keep down the dust on the repaired half of the avenue frequent sprinklings have been necessary. These, with the rains and surreptitious efforts of the town's street cleaners, has kept the surplus litter off the new roadway and somewhat reduced the dust nuisance.

East Orange, N. J.

Possibly a greater measure of success in keeping down the dust nuisance and in protecting pavements against excessive wear has been attained in the city of East Orange, N. J., as will be observed, than in any of the other districts herein noted. On the principal residence streets of the city one is first impressed with the apparent permanentness of construction, with general smoothness of roadway and the preservation of section contour, with the absence of litter and with the small amounts of dust flying from the traffic cushion covering the pavements. Investigation discloses very definite reasons for these impressions.

In the first place, all improved streets are laid out with a telford-macadam pavement from gutter to gutter; all the gutters are paved in some way and all are curbed. This gives the impression of work completely and enduringly done. The expense of building all these telford pavements, gutters and curbings is assessed upon the property owners benefited, and repayment is demanded in ten annual installments. Such construction is made by the city, under the supervision and upon the design of the city engineer, on petition of the property owners and by ordinance of the city. After a roadway has once been constructed the burden of repairs and maintenance is assumed by the city and paid out of the appropriations made by the City Council for street work. Repairs, maintenance and cleaning are under the direct control of the City Engineer, Mr. Frederic A. Reimer, Assoc. M. Am. Soc. C. E. Therefore, as large appropriations can be made for the street work as in any city of the size and character without unduly burdensome taxation and yet with more effective results in the general up-keep, as no money has to be diverted to the expensive items of original construction.

CLEANING.—The general smoothness, preservation of contour noted and absence of excessive dust, even in the presence of an appreciable traffic cushion over the "metal" of the pavements, may be attributed to the close attention to repairs thus made possible and to a fair degree of success accompanying the surface treatment of the pavements. The absence of excessive dust must also be attributed in part to the regular cleaning which all streets receive. Three men are employed to patrol the streets for the removal of paper and debris and the principal streets are hand swept every one to three weeks, according to traffic, so that there may be no very great collection of litter to be reduced to dust and flying infection. East Orange has a level location, compared with the neighboring town of Montclair, and no reliance is placed on the pavements being self-cleaning, as in the latter place, by rains washing litter into the gutters and sewers. Moreover, the crowning of all pavements is not made as marked as in Montclair (being approximately from 6 to 12 ins. for streets from 28 to 70 ft. in width).

In 1909, 838 cu. yds. of material were removed from the pavements in this city, which represents about ½-in. of the road surface. This would indicate the need of resurfacing about once in eight years. Owing, however, to the concentration of wear in the center of the roadways, it is found that the older macadam roads require surfacing slightly more often or about once in each seven years. This means at present the reconstruction of about seven miles each year. The careful recording of the amount of street sweepings seems to be unique here and it is being caried further so as to furnish a measure of the increase or decrease of wear under increasing traffic on new pavements.

SAND.—The use of clay has been abandoned as a binder of the upper layers of broken stone, and as the streets are resurfaced a coarse sand is used as a binder. The general result, as expressed by the City Engineer, is a more durable and a cleaner road on which there has been a decided reduction of maintenance expenses. The record of some 67,000 sq. yds. resurfaced in 1909 shows an average of 0.0125-cu. yd. of sand per sq. yd. of street—about two and a half pecks per sq. yd. This reconstruction has been done at an average cost of about 28 cts. per sq. yd.

OILS.—In 1906 it was decided that steps must be taken to prevent the excessive wear and consequent dust that accompanied the rapidly in-

creasing use of motor vehicles. After careful consideration, in June, 1907, one principal residential street, which had been resurfaced in 1906, was treated with a 60% asphaltic oil, furnished by a Kentucky concern. The roadway was first carefully hand swept to remove all litter, dirt and dust. The oil was then sprinkled on, a gallon to 2¼ sq. yds. It was well brushed in and allowed to penetrate and dry for three days, during which time traffic was kept off. The cost of the treatment was 5½ cts. per sq. yd. The stone was found well cemented together and the penetration was from ¾ to 1½ ins. This road proved desirable in every way, improving as the season advanced. Dust was negligible, with the system of cleaning up litter once in two weeks, and in rainy weather there was no mud. This surface is reported to have retained these desirable characteristics for ten months, or until late in the following spring, before appreciable wear was shown. In a few odd places on this particular street, all where the traffic has been very light, the original oiled surface is still intact and is in as good condition as during the first season. Previous to this oil treatment, 12 cu. yds. of sweepings had been removed every two weeks; afterwards, the sweepings for the same period were not more than 4½ cu. yds.

The road was treated again in 1908 with an oil supposed to be the same as used before and purchased from the same company. The oil proved to give entirely different effects, and investigation showed that it was not from the same source and contained in all probability a great deal of paraffin, which seemed to kill its binding properties. With each rain the surface would churn up into a thick greasy mud which was very objectionable.

In the course of the 1908 work, in hope of avoiding the necessity of closing a street to traffic for several days, the scheme of immediately covering the oil with sand was tried, but with poor success. The application of sand before the oil had begun to harden and perhaps in connection with the poor oil received that year, caused disintegration so that the surface tended to scale up in large patches. In 1909 the oil experiments were continued; the roadways were cleaned, as already noted, and a 65% asphaltic oil was sprinkled on and swept in; finally, after a few hours, ½-in. of trap rock screenings were spread over the oil and well rolled down with a 10-ton tandem roller. This procedure allowed traffic to go onto the road as soon as the work was completed. At first it was believed that this treatment was going to give as great satisfaction as the original experiment noted, for the road had a smooth, hard surface which was free from dust, under the system of cleaning once in two weeks, and did not cut or flow under traffic. However, whenever rain fell the traffic cushion, which had been consolidated into a solid mat, churned up into an oily mud. In a few hours after rain stopped these roadways dried out and the mat ironed out as hard and smooth and dustless as before.

The poorer results attending these experiments, compared with the results of the first use of asphaltic oil, are attributed by the City Engineer wholly to the poorer quality of oil and not at all to the method of application. At the same time, everything that promotes a good distribution and deep penetration of the oil is approved. To this end, a high-pressure sprinkler has been successfully used. It is considered essential to allow any asphaltic oil to remain as distributed for five or six hours before being covered with screenings to secure sufficient penetration and evaporation of volatile matter to give a bond between the old pavement and the new surfacing. It is believed here that the quantity and quality of the asphaltic base in the road oils purchased needs to be fixed by specifications and tests, both chemical and mechanical, to reproduce the success found at first.

In resurfacing one street, where the top stone had been worn down, a heavy asphaltic oil was used as a binder. The under stone was scarified to secure a mechanical bond and a 5-in. layer of 1½-in. stone was rolled down in place. The oil was spread on hot (150° F.) about 1¾ gals. per sq. yd. A ¼-in. coat of screenings was added and the roadway was given a final rolling with a 10-ton tandem roller. The cost of such resurfacing worked out at very nearly 46 cts. per sq. yd. The result with this road has been only fair, as the surface has proven entirely too soft so that it cuts and creeps under traffic even in dry weather.

One street has been resurfaced in a similar way, but with a good grade of California (asphalt) oil as binder, costing about 12½ cts. per gal. This oil was heavier than Eastern oils and had to be heated to some 300° F. before it could be properly applied. This road appears to be satisfactory and it is expected that the binder will retain sufficient elasticity in the coldest weather (10° F.) so that the surface will not crumble under traffic.

TAR.—Tar macadam has not been as extensively constructed in East Orange as in the neighboring town of Montclair, perhaps on account of a more level situation. The use of this and similar proprietary pavements is being tried, however, on a scale that should determine its economic place among the other types here. With the assessment scheme of paying for new construction, the tendency is for property owners to ask for the cheaper telford and thereby to throw the heavy burden of surface maintenance and dust laying upon the street department's appropriations.

There is a half mile stretch of parkway in this town on which a telford base carrying a tar-bound surface was laid this season by the Essex Park Commission. This was laid with prepared tar-concrete materials and has given good service since it has been in use. Litter is regularly removed by hand sweeping, but even then the roadway can hardly be called dustless on a dry summer day.

Throughout this city the tar-bound and similar roads are sprinkled with water whenever the traffic increases enough to make a dust nuisance which the regular cleaning cannot reduce.

ASPHALT.—A proprietary surfacing has been put down in several parts of the city by contract. On the heavy telford bottom was spread an asphalt-concrete layer some 3 ins. thick and on this a layer of finer asphaltic material (said to contain Portland cement) giving the completed surface much the appearance of asphalt. The cost is reported to be about $1.50 per sq. yd., as compared with $1.25 for the common telford.

MAIN ST.—East Orange has the problem which is universal in cities of this class, of a principal business thoroughfare on which a very heavy traffic is confined to a narrow path by a double car track through the center of the street. This Main street (in name as well as fact) now has a telford roadway from gutters to outside rails of the electric railway track. Inside the rails and between the parallel tracks is a Belgian block paving. The wear on the stone roadway is so heavy that the roadway has to be resurfaced about every year and the annual cost of maintenance and minor repair is excessive, amounting to somewhere about $3,500 per mile. Creosoted wood-block paving, on a concrete base, has been recommended by the City Engineer as best adapted to the conditions prevailing. As the grades on Main St. are less than 1% for most of its length, the objection of slipperiness is not expected.

Essex County, N. J.

Mr. James Owen, County Engineer, recently reported the successes and failures of the county roads under his jurisdiction.* The system has a total of 150 miles, of which some 10 miles is urban in character, 50 miles is suburban or interurban, and 100 is strictly rural.

Three years ago, when the macadam roads began to go to pieces rapidly, it was decided to renew about 25 miles with new stone and bituminous binder; some 65 miles were to be treated with heavy asphaltic oils. Trial renewals were made with what was supposed to be a 96 to 98% asphaltic oil, which had to be heated before applying. The oil was applied and the stone was rolled to consolidate it, screenings being applied to prevent the oil from sticking to the rollers. The new surface, however, began to creep and crawl, as soon as hot weather came on; ruts appeared and humps, 6 ins. high and 2 ft. long, were formed. In a few places, amounting to about 30% of the total relaid surface, a good and satisfactory pavement resulted. In the fall of 1909 another attempt with this type of reconstruction was made. The specifications for the materials were carefully prepared and competent chemists advised on the oils. The materials were tested and laid by responsible contractors. Nevertheless in the spring the surface entirely broke up and the section had to be resurfaced.

After much experience all attempts to apply asphaltic oils, by the penetration scheme, before consolidation of the new stone, were abandoned. Roads were rebuilt as common water-bound macadam and when the surface had worn smooth enough, a 40 to 50% asphaltic oil was sprinkled on, about ½-gal. per sq. yd. The maintenance contracts for new macadam roads provide for two such applications in the year.

Considerable oiling has been done, merely to keep down the dust. The early applications were of heated heavy asphaltic oils and were intended to last for a season. On heavy grades the foothold for horses was decreased and sand and screenings had to be put on, adding to the expense. Later, lighter oils, having about 40 to 50% asphalt, were tried with better success. On truly rural sections, one application served for the season and elsewhere two coats were needed.

Whenever the surface began to ravel or break up before the oil was applied no benefit was received from the oil, either in holding the road together or in keeping down the dust. This tendency toward disintegration was found most pronounced in spring when winds and rains cleared off the traffic cushion which had accumulated. The roadways at such times were sprinkled with sand or loam which consolidated the metal under ordinary travel and soon gave a smooth surface. Then the first oiling of the season was made and a good surface obtained. There was still more improvement by adding a light coat of screenings a few hours after the oiling.

Mr. Owen believes that the problems to be faced in this county are the increased cost of maintenance due to motor travel and the determination of the most economical construction and maintenance. The original cost of maintenance of the system, prior to the automobile, was 3 cts. per sq. yd. per year, but the increased prices of later years raised this to 5 cts. A proprietary surfacing, having asphalt binder largely, has been used at a cost of from $0.75 to $1.25 for renewals of macadam. Surface sprinkling of 50% asphalt oil in 1910 was a little less than 1 ct. per sq. yd. As Essex County has mostly main thoroughfares, one application was insufficient for about half the system. Assuming therefore 1½ cts. per sq. yd, as an average and 5 cts. for the annual proportions of surface renewals, the annual cost has been estimated at 6½ cts. per sq. yd. To meet this figure the asphaltic-macadam renewals must last 10 or 12 years.

Stamford, Conn.

The city of Stamford, Conn., although 33 miles from New York City, has the appearance of the other outlying suburbs, and it is indeed a suburb of the city, as the New York, New Haven & Hartford R. R. is used by many commuters. The city has about 25,000 inhabitants, residing on some 70 miles of streets. Of all of these streets, 15 miles are unimproved in any way other than by an occasional shaping up and in some cases an occasional treatment to reduce dust. These streets are comparatively little traveled. There are about 28 miles of rolled pit gravel, 25 miles of macadam, some of which has a telford base, and 2½ miles of city block pavement in the business streets. Maintenance and construction in this city is under the jurisdiction of Mr. Paul Nash, Superintendent of Public Works.

OIL.—In all the city there is not found a single piece of bituminous macadam of any sort. A method of treating ordinary macadam has been developed to a satisfactory point whereby the useful life is increased and dust is very largely elim-

*In a paper read before the New Jersey Sanitary Association, Dec. 8, 1910. This summary is based in part on that paper.

inated. The treatment developed here consists of sprinkling on the surface, after a thorough sweeping, about ½ gal. of 50% asphaltic oil once a year. After a thorough brooming in this application a light coat of sand or stone screenings is thrown on. The oil used follows no rigid specifications, as practically the same success has been secured with the same weight of mixtures furnished by several different concerns.

It is considered essential, in preserving the roads by this treatment, to watch them carefully from day to day. As soon as a spot appears to give evidence of a tendency to ravel, it is hand-sprinkled with oil which is broomed in and covered with a light top coat of screenings. Should the spot go to pieces before this repair could be made, so that a slight pot-hole should develop, it is filled in with ¾-in. stone, tamped. Then the spot is sprinkled with oil and given a layer of sand or screenings.

On gravel and dirt roads the attempt is rather to prevent dust than to secure a compact traffic cushion. A 50% asphaltic oil is applied in a specially arranged "dribble" sprinkler by which a small uniform distribution is secured. On these roads less than ¼-gal. per sq. yd. is applied at a time, and by repeating the treatment once a month or thereabouts all complaint has been eliminated from the property owners. This very light application of oil is made to one-half of the street at a time and in a day or two it has so dried in or been absorbed by the road material that there is no trouble from tracking.

Light tar preparations have been applied to a few macadam roadways during the past season and up to this time the condition of the pavements compares favorably with those upon which heavy asphaltic oil was used.

One of the heaviest traveled automobile thoroughfares outside of New York City is the so-called Boston Post Road, which forms the main highway for automobile traffic between New York and Boston. At Stamford this is a macadam road constructed by the State of Connecticut, but maintained by the local officials. By the annual application of oil, as described, on this road, a dense elastic traffic cushion which remains practically dustless for the entire season, has been built up on top of the stone. In many places the road resembles asphalt. On holidays and special occasions, the automobile traffic over these oiled sections rises to as high as from 100 to 200 per hour. The only loosening of the stone which gives trouble is occasionally on a very steep hill, and by attention to the road this can be largely kept to a minimum.

It is not believed at Stamford that the oil penetrates sufficiently into the mass of broken stone and filler to furnish any appreciable bond, and the appearance of the road where, for any reason the surface cushion has been broken or removed, supports this opinion. It is here believed that the upper surface of the road acts in a measure as a filter so that the asphalt content in the oil practically remains at the surface while the fluxing contents soak below but do not effectively bind. The fluxing oils so absorbed by the broken stone and filler is believed, however, to serve a useful purpose in keeping soft the thin upper layer of asphaltum-bound material.

COSTS.—The average cost of cleaning and oiling the macadam streets in Stamford in the way described, has amounted to 3½ cts. per sq. yd. In the case of the Boston Post Road, somewhat more oil is added than to the other and less traveled streets so that here the cost rises above this figure. The maintenance of all roads and pavements and the construction of new pavements, with the exception of permanent city block pavements, is borne by annual appropriations amounting to about $28,000. This has to cover, however, the cost of cleaning litter from all thoroughfares in the city, cleaning and building catch basins, and cleaning gutters, so that probably not more than $18,000 is available for the maintenance of the 70 miles of roadway mentioned. Not much new macadam and gravel road is being constructed at the present time in the city (in the past year about 7 miles have been resurfaced with gravel and 2½ miles with macadam), so that nearly all the $18,000 goes to the actual road maintenance. While the care of the roads here is stated to be generally satisfactory to the citizens, yet it is believed that if more money were available more of the roads could be kept in the condition of the Boston Post Road.

MUD.—Under this method of treating the macadam roads very little trouble has been experienced with the churning up of the traffic cushion into a slimy mud, as found in other places to a greater or less extent. Where the asphalt-bound top layer is kept well ironed down by automobile tires, it is found that it will stand a continued rain of two or three days before it commences to churn up into mud, and even then after the road has had an opportunity to dry out it is soon ironed down into practically its former condition. On streets where there is less automobile and more horse traffic, so that the asphalt-bound mat is not so well ironed out and is kept more or less chopped up by the horses' feet, there has been a tendency to form a slippery mud after a much shorter rain, say, one continuing for several hours, but this has not been judged so unpleasant as to arouse much criticism from the property owners affected, and it is not easily picked up by vehicle wheels.

Most of the roads in Stamford are given a considerable crown, varying from 5 to 8 ins. for roadways between 12 and 20 ft. wide. By the use of such crown, the passage of traffic over the road works the accumulations of litter to the gutter, where it is washed into the sewers at times of storms or is removed by the street cleaners.

Greenwich, Conn.

In the town of Greenwich, only a few miles from Stamford, the office of Superintendent of Highways was established by a bill, passed by the last Legislature, changing the form of local government. The Superintendent, Mr. Leon F. Peck, has begun the development of systematic road construction and maintenance but few results are available at present since one year has been found too short to secure adequate records for comparison or to pass fairly on the merits of different types of construction under different conditions of sub-soil, traffic, etc. In the work recently completed is a 3,000-ft. section of telford roadway, with four different bituminous binders.

Some 40 miles of common roads have been treated with light oils to lay the dust. Old macadam surfaces have been swept and sprinkled with heavy asphaltic oils. In both cases satisfactory results have been secured.

THE FIRE PROTECTION OF CONCRETE BUILDings should go further than mere construction in concrete and should provide the usual accessory fixtures and precautionary details, according to the annual report of the Committee on Insurance of the National Association of Cement Users. Discussing the matter of insurance rates on concrete buildings, which the Committee thinks are too high, the report says:

The main cause for the high rates reported is the lack of proper installation of recognized fire prevention equipment, together with the lack of information on the part of the owner regarding the construction details, in advance of making his investment; that is, owners have not equipped their buildings in accordance with the best known practice conducive to low rates of insurance.

Ordinarily, the owner thinks that he has done enough when he builds of concrete according to standard practice and is apt to think less of that type of construction when he finds that the fire insurance companies will not give rates much lower than on types of construction admittedly less safe, but which are protected by the various additional equipments. The report therefore recommends:

The following list of details of construction have been most emphasized by the Rating Associations, and should be investigated by owners before letting contracts for buildings where the cost of insurance plays an important part in the investment:

1. Sprinkler equipment with ample water supply.
2. Water-tight floors with proper drains or scuppers and vertical openings guarded by automatic closing devices.
3. Proper cut-off walls with automatic closing doors and automatic fireproof windows. (Size of divisions of the building to depend on the inflammability of the contents.)
4. Notification systems for out-break of fires.
5. Fire fighting apparatus independent of city or town fire departments.
6. Stair and elevator wells properly cut off by automatic closing doors and fireproof apparatus.
7. In addition to the above details, a typical rating slip gives some 50 items of equipment, construction or management, any or all of which affect the rate obtainable.

If these details are attended to it is hoped that the insurance rates on concrete buildings will be reduced measurably.

The Paris Subway System—With Special Reference to Franchise Terms and Conditions.

By ROBERT H. WHITTEN.*

HISTORY OF PROJECT.—The project for a rapid-transit railway for Paris dates back to 18[illegible]. From that year until 1898, when the law declarative of the public utility of the Chemin de fer Métropolitain was passed, projects were submitted with increasing frequency and insistence. The development of a rapid-transit system was delayed for a long time owing to the inability of the state and city authorities to come to an agreement in regard to the fundamental purpose and function of the proposed system. The state authorities looked upon the project primarily with reference to its value in the general railroad system. It should connect the existing steam-railroad terminals and permit a convenient transfer of passengers, baggage and freight from one terminal to another. It should also serve to carry passengers and freight from the existing terminals into the heart of the city. On the other hand, the city authorities took the ground that a service of this kind would be incompatible with an efficient rapid-transit service. They contended that the controlling function of a rapid-transit line should be the transportation of the residents of the city between their homes and their work or recreation. The linking up of railroad terminals, while important, should not be a controlling feature and in any case there should not be a direct combination on the same tracks of two distinct and incompatible systems—city rapid transit and through or trunk-line traffic. They contended that an efficient rapid-transit service requires the running of trains at very short intervals and the introduction of heavy trunk-line trains could scarcely fail to disorganize the local service and be a source of danger in operation.

Legally there are three classes of railways in France: (1) Railways of general interest (chemin de fer d'intérêt général); (2) railways of local interest (chemin de fer d'intérêt local); (3) tramways. The distinction between railways of general interest and railways of local interest is one of degree rather than of kind. The decision as to the class to which a particular road shall belong rests with the Minister of Public Works and ultimately with Parliament in its approval of the law declarative of the public utility of the enterprise. Railways of general interest are entirely under the control of the central authorities. A railroad of local interest is committed primarily to the control of the communes and the department in which it is located. Accordingly, if the view of the state authorities as to the function of the proposed rapid-transit line prevailed the line would be considered a railway of general interest and therefore a subject for state determination and control. If on the other hand the view of the city prevailed the proposed rapid-transit line would be a railway of local interest and subject primarily to the determination of the city council. After numerous proposals and counter proposals, and investigations and reports by various state authorities, the Minister of Public Works conceded that the proposed system would in the main serve local needs and should be classed as a railway of local interest. Nevertheless, the plans would finally come before Parliament for approval, at which time it would be possible to insert such stipulations as were deemed essential to safeguard the interest of general traffic. The city council accordingly adopted plans of construction and entered into an agreement with a private company for the operation of the system. These were finally made effective by the law of March 30, 1898, declarative of the public utility of the Metropolitan railway.

Partly to render impossible any possible future direct physical connection between the city subway system and the trunk-line railways, the plans adopted by the city provided for a narrow gage line. Fortunately, this was, however, vetoed by the state authorities and the lines

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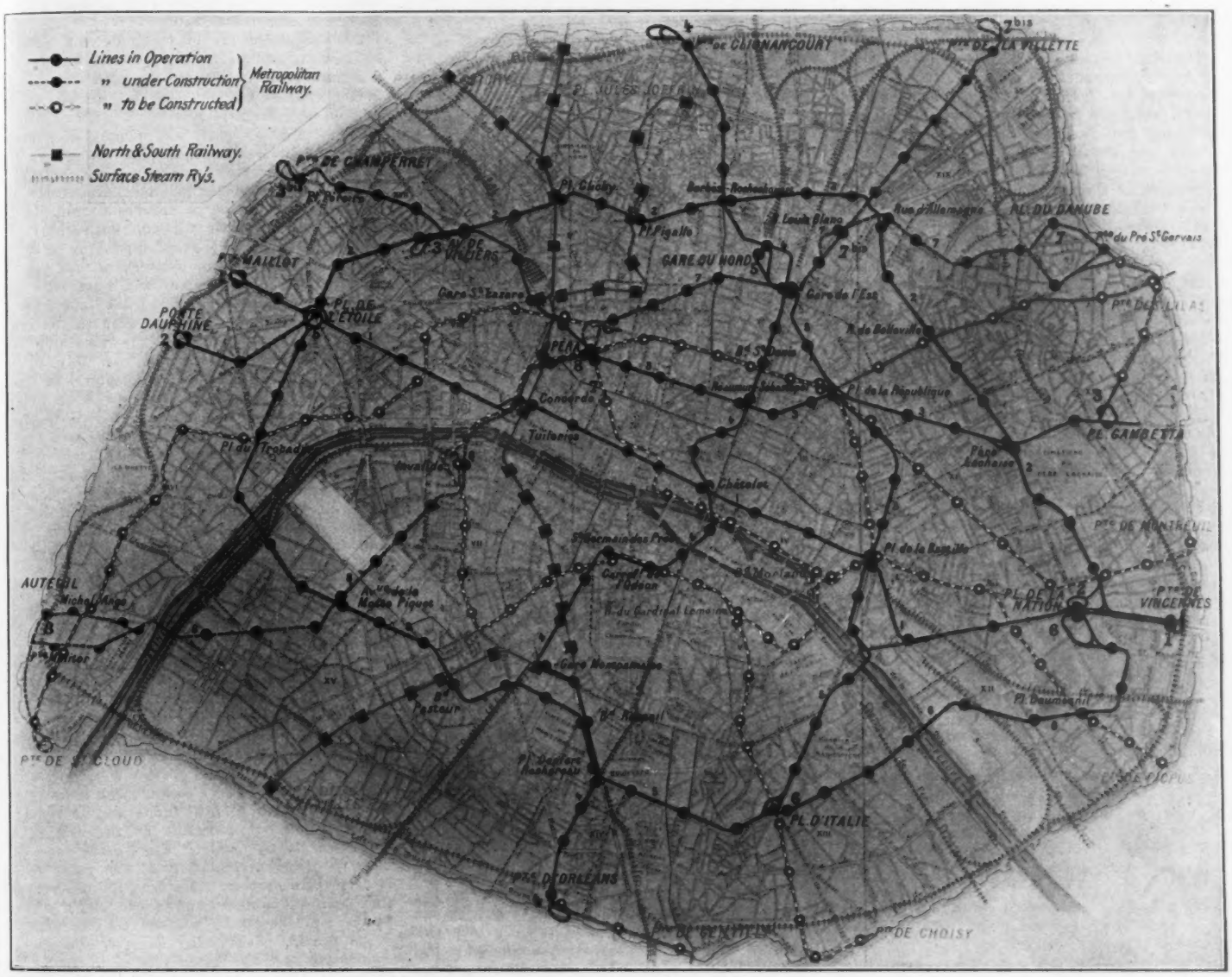
constructed are of standard gage, but the subways and tunnels are too small to admit the equipment of the main-line railroads. While, therefore, the standard gage being used, the trains of the subway system can, if desired, run over the tracks of the trunk-line railways, the cars of the trunk-line railways cannot be used in the subways.

The Royal Commission on London Traffic, in its report made in 1905, calls attention to the different requirements of an urban and suburban rapid-transit service. The Commission states that it is essential that the service on an urban rapid-transit railway should be so frequent as to be practically continuous and states that "it is of vital importance not to attempt to use urban railways in any way, or for any purposes, which



MAP OF THE RAPID TRANSIT SUBWAY SYSTEM OF PARIS.

may prevent the running on them of train services of maximum frequency." Whether the same tracks can be used for both urban and suburban rapid transit is a question of practical railway working, "but it is obvious that the use of a line for one of these kinds of traffic may destroy or impair its utility for the other." The suburban traffic of London is largely cared for by the main-line railroads. The Commission states that one of the functions of urban rapid-transit is to link up the trunk-line terminals in such a way as to carry the suburban passenger to his destination in the central area, but the Commission adds that care should always be taken "not to use the urban railways in any way which would prejudice the performance of their main function of supplying continuous services at close intervals for urban traffic." The following is from the report of the Commission: (V. 1, p. 55.)

It is necessary at the outset to form a clear conception of the functions of railways as part of the general scheme for locomotion and transport in London. For this purpose, we must consider separately the requirements of (1) passengers and (2) goods traffic; and passenger traffic, for present purposes may be conveniently classified into (1) urban, (2) suburban and (3) long-distance—including all traffic beyond suburban limits.

As regards urban and suburban traffic, it is most important to consider separately the requirements of each. Their needs are wholly different in character, and many of the mistakes of the past have been due to not keeping this distinction in mind with sufficient prominence. Whether the same tracks can be used within the central area for trains serving both classes of traffic, or to what extent they can be so used, are questions of practical railway working, but it is obvious that the use of a line for one of these kinds of traffic may destroy or impair its utility for the other. The considerations affecting location, accommodation and working are radically different, and, to some extent, conflicting; and the absence of comprehensive design in the railway system in London, is nowhere more apparent than in the confusion which has arisen from not distinguishing, with sufficient clearness, between the requirements of the different classes of traffic. Railways, intended for urban traffic, have been used, and partly designed for suburban traffic to an extent and under conditions which have adversely affected their utility for both purposes.

PRIVATE VERSUS MUNICIPAL CONSTRUCTION.—The subways of Paris included in the Metropolitan system are built and owned by the city and leased, equipped and operated by a private company. This conforms to the practice provided in the first general law for the construction of railroads in France, of June 11, 1842. This law provided for the construction of the roadbed at public expense and for equipment with tracks and rolling stock by the operating company. Subsequently the policy of granting aid to new railroads through a government guarantee of a minimum profit became quite general and is still much used.

The city had the choice between these two systems: (1) municipal construction and ownership and (2) guarantee of a minimum profit to a private company. If the city built the subway the term of the concession could be much shortened. It is a universal custom in France to require that a railway structure shall revert without payment to the city or state at the expiration of the term of the concession. To provide for the amortization of invested capital it was estimated that a 75-year term would be necessary if the company should construct the subways, while a 35-year term would be sufficient with municipal construction. The city could borrow money at 3.3%, including amortization, while the capital secured by a private company would average 5.5%, including amortization.* It was estimated that the city's financial risk would be less if it should build and lease the subways than if it should guarantee a minimum interest on the investment of a private company. In addition, the term of the concession could be less than half as long as would be required under private construction and the city would also be able to exert a more continuous and effective control over the development and operation of the subway system.

But while the city assumed the building of the subway proper, including the tunnels and viaducts, the entire equipment of the roadbed thus furnished was left to the operating com-

*Révérard, Des Conditions d'Exploitation du Chemin de fer Métropolitain, p. 164.

pany. The company provides the track, power plants, electrical equipment, shops, cars, station entrances, ticket booths and in fact the entire station excepting the platforms. This division of responsibility between the city and the company seems logical. It does not seem desirable for the city to supply the operating company with equipment that is subject to rapid depreciation. This would seem to be a rule applicable generally to relations between lessor and lessee. It is desirable that the lessee should have a direct financial interest in the permanent upkeep of all equipment subject to rapid depreciation.

PRIVATE VERSUS MUNICIPAL OPERATION.—Though there was a very considerable sentiment in favor of municipal operation of the subway system, private operation was decided on. The vote in the special commission of the city council was 14 to 10 in favor of private operation. It was urged that this was a new and untried system of transportation and that the city ought not to undertake it until the success of the system had been demonstrated and its principles established. But the principal reason for the choice of private operation was the fact that under the existing decisions of the Council of State and the attitude of the State Department of Public Works and of Parliament, it was thought that a proposal for municipal operation would be vetoed.*

NEGOTIATION OF THE LEASE.—Here the first question to be settled was whether the plan of competitive bids or individual negotiation and agreement should be used. The latter method was adopted. It was preferred by most of the prospective bidders and promised more satisfactory results to the city. Objections to competitive bidding were as follows:

(1) The competitive method is not applicable to a concession of such enormous importance and containing elements of evaluation so complex and diverse. The city must consider: (a) the interest of the public, including the subjects of fares and service; (b) the financial interest of the city, including the payment for the lease, the term of the lease, etc.; (c) the financial responsibility of the bidder. It was urged that these various factors could not be rated in advance in accordance with any fixed scale of values so as to determine in any rigid way the relative advantage of complex proposals.

(2) The bidders prefer to discuss with the city authorities the terms of the lease. Certain details of little importance to the city may seem very important to the prospective tenant and vice versa. By negotiation each party is able to secure the maximum of satisfaction at the minimum cost.

(3) The competitive bid requires that the scheme be worked out in all its details and in final form by the city before asking for bids and that the bidders shall make most expensive and detailed studies of the same. This initial expense may deter some persons from submitting bids who would be prepared to submit more general proposals and would work out the details in case their general plans met with the approval of the city authorities.

Having decided on the method of negotiation in preference to competitive bidding a prefectoral decree of Feb. 28, 1897, made public a draft of a plan for the construction of the subway system and a draft of a proposed lease of the same. This draft was intended to serve as a basis of discussion, and anyone could submit such proposals as his experience might suggest. The city would then enter into negotiations with the one whose plan seemed on the whole most advantageous. Proposals were required to be submitted by April 5, 1897. A prefectoral decree of April 2, 1897, created a special Commission for the consideration of these proposals. This Commission consisted of the Prefect of the Seine as president, the General Secretary of the prefecture, six members of the municipal council, four members chosen from the municipal administration and four members drawn from various branches of the state-administrative service. Six proposals were submitted to this Commission. Two of these were at once dropped as being clearly undesirable. The Commission then formed a sub-commission charged with entering into negotiations with the remaining four parties. The sub-commission after these negotiations eliminated two of the four because of fundamental objections to their proposals. The sub-commission made its report to the full Commission on April 14, 1897, submitting to its consideration the proposals of M. Lalance and the Compagnie Générale de Traction, with a preference for the latter.

M. Lalance offered a guarantee of 100,000 francs per kilometer of line operated, in case payment to the city of 5 centimes (1 ct.) on each ticket sold should be insufficient to cover interest and amortization of the city's expenditure for construction. He refused, however, to include the power plants and shops among the property that would revert to the city at the expiration of the lease unless the term of the lease should be extended to 50 years. He refused also to grant workingmen's round-trip tickets at a reduced rate.

The Compagnie Générale de Traction refused a guarantee per kilometer of line operated in case of the insufficiency of the payment of 5 centimes per ticket to cover the interest and amortization charges on the city's payment for construction. The company asserted that such a guarantee would diminish the interest that the city should feel in the financial success of the enterprise. The company asked also that a first-class fare of 25 centimes should be established of which 10 centimes should be paid to the city. The city's proposition was for a single 20-centime fare of which 5 centimes should go to the city.

The Commission decided that the proposition of the Compagnie Générale de Traction was the most advantageous for the city and authorized its sub-committee to arrange with the director of the company and the counsel of the city the text of the lease. The negotiators quickly arrived at an agreement on all but a few points. Chief points of difference were the provision for purchase by the city at any time after 1910 and provisions in relation to the order of construction of the various lines of the system and the period within which the city is required to complete different portions of the system. Agreement was finally reached on these points and the lease or concession was signed Jan. 27, 1898, by the Prefect of the Seine acting in behalf of the city and by the President of the Compagnie Générale de Traction. Under the terms of the concession the company agreed to organize a new company to take over the concession and equip and operate the road. The Compagnie du Chemin de fer Métropolitain de Paris was accordingly organized and now operates the Paris subway system.

DECLARATION OF PUBLIC UTILITY.—The concession having been signed Jan. 27, 1898, it was still necessary that the project be passed on by the state authorities and a law declarative of the public utility of the enterprise be enacted by Parliament. The project and the terms of the concession were examined by the Council General of Roads and Bridges and by the Council of State. These bodies recommended certain changes in regard to proposed provisions for the protection of employees and in relation to the gage of the track, the size of the tunnels and the prevention of interference with possible future railroad tunnels. The Minister of Public Works then drafted a law declarative of the public utility of the Metropolitan and approving the concession entered into between the city and the company with certain important modifications and stipulations. This bill was considered by the committees of the two houses of Parliament and was passed and signed March 30, 1898.

EXTENT OF SYSTEM.—The Metropolitan system as originally planned included only about 46.6 miles (75 kilometers) of double track. Minor extensions were authorized by special laws May 22, 1902, April 6, 1903, and Feb. 26, 1907. The first line of the Metropolitan was opened in 1900 and its success was so marked that in June, 1901, the City Council adopted a resolution asking the Administration to plan a comprehensive extension of the system so as to provide a complete system of rapid-transit for the city. Accordingly, in December, 1901, the Prefect of the Seine transmitted to the council a report and plan prepared by M. Bienvenüe.* This plan was devised with the following objects:

(1) To supply the lack of surface transportation and especially to serve the sections distant from the center.
(2) To serve practically the entire city by means of railways, chiefly underground, and possessing a zone of attraction a quarter of a mile (400 meters) wide on each side of the line.
(3) To provide, for the future, the possibility of convenient connections with the lines of the proposed suburban system of the Department of the Seine.

This comprehensive system as finally worked out was adopted by the City Council in December, 1907. Laws declarative of the public utility of the enterprise were passed July 31, 1909, and March 30, 1910.

The extensions provided include 34.1 miles (55 kilometers) of line. This is what is known as the third system. The first system was included in the original act of 1898, and the second system in supplementary acts of 1902, 1903 and 1907. The first system was completed in March, 1908, and the second system in December, 1909. It is estimated that the third system will be completed within five years. These three subsystems are intended to provide a complete system of rapid-transit for the entire city. As will be seen from the accompanying map, the lines form a complete network within the city limits. The entire system will have 82.9 miles (133½ kilometers) of double-track line of which 73.3 (118 kilometers) will be used in the transportation of passengers and the remaining mileage for connections, terminals, etc. Jan. 9, 1910, there were 37.6 miles (60.5 kilometers) of line in operation. There will be 12 lines of an average length of about 6 miles each. There is one line of about 2½ miles, and the longest line is 9.3 miles. Several lines run across the city from wall to wall. Four of the lines form two complete loops, one within the other. There is a large loop (line No. 2 north and line No. 2 south) running at a radius of about two miles from the city center and a small loop at a radius of about one mile from the city center.†

COMPETITION VERSUS MONOPOLY.—In developing its rapid-transit system the city has held with a single exception to the principle that the entire system should be owned by the city and leased by it to a single operating company. Such a system, joined with the requirement of free transfers and transportation from any one point on the system to any other point for a single uniform fare, possesses very great public advantages. In 1899 a request was made for a franchise to build and operate a subway across the city from north to south. The subway was to be built with private funds and to revert to the city without payment at the end of the franchise term, which was made to coincide with the termination of the lease of the Metropolitan system. The need for the proposed line was undoubted and as the city's finances would be relieved by private construction, the city's consent was finally secured and the law confirming the concession passed in 1905. The unity of the rapid-transit system was maintained, however, by requiring the North-South Co. (Chemin de fer Nord-Sud) operating the independent subway to exchange transfers with the Metropolitan Co. It will be possible, therefore, to travel from any point on the lines of either company to any point on the lines of the other company for a single fare.

FARES.—The concession granted the Metropolitan Co. fixes the following rate of fare: First-class, 25 centimes (4.8 cts.); second-class, 15 centimes (2.9 cts.); round-trip tickets, second-class, good for return at any time on day of purchase are sold up to 9 a. m. for 20 centimes (3.8 cts.). Pupils of the communal schools of the city of Paris are transported for 5 centimes when traveling in groups accompanied by a teacher.

*Révérard, op. cit., pp. 174-76.

*M. Bienvenüe is the engineer at the head of the bureau for the construction of the Metropolitan (Service Technique du Métropolitain).

†The lines of the large loop are in operation. The projected small loop was added to the system by the agreement of December, 1907.

For a single fare the passenger has a right to travel from any one point on the entire system to any other point. Free transfers are allowed at all crossings and junctions.

The city's original proposition to the company was for a single 20-centime (3.8-ct.) fare. The company felt that a lower fare would be necessary to attract a certain class of passengers. The company, therefore, proposed a uniform fare of 10 centimes (1.9 cts.) on condition that the payment to the city should be 2 centimes in place of 5 centimes per ticket. The city rejected this proposal, as it feared that the increase in travel due to the reduction would not make up the loss of revenue that the city would sustain, and as a result, the city would not receive enough to cover interest and amortization on the cost of construction. As a substitute the system of first and second-class tickets and special round-trip tickets was adopted. The city proposed that second-class round-trip tickets should be issued only before 8 a. m., but the hour was changed to 9 a. m. at the suggestion of the company. The company considered that by selling the special round-trip ticket up to 9 a. m. it would secure the patronage of many clerks and other employees that it would not otherwise obtain.* Under the terms of Article 28 of the Concession, the company may, with the approval of the Prefect, lower the fares charged either for the whole or a part of the system. No authority is granted to compel a reduction of fares below the rates fixed in the concession.

For 1909 the proportion of tickets of various kinds sold was as follows: first-class, 10.68%; second-class, 65.60%; round-trip, 22.70%; group tickets or school tickets, .02%. Each round-trip ticket, however, means two rides, and if we take the number of rides instead of the number of tickets, the percentages for 1909 will be altered as follows: first-class, 8.62%; second-class, 53.03%; round-trip, 38.32%. In comparison with the proportion of rides for each class of ticket, it is interesting to note the proportion of receipts from each class, which was in 1909 as follows: Receipts from tickets of the first-class, 15.39%; second-class, 56.75%; round-trip, 27.34%. The round-trip fare of 1.9 cts. each way (3.8 cts. round trip) is one-third less than the single second-class fare of 2.9 cts. Considering the extent of the Metropolitan system and the privilege of the free transfer, this makes it a very reasonable fare. For 1909 the average fare received was 2.7 cts. (14 centimes).

FREE TRANSFERS BETWEEN METROPOLITAN AND NORTH-SOUTH SYSTEMS.—In the concession granted in 1905 to the Compagnie du Chemin de Fer Electrique Souterrain Nord-Sud de Paris for the construction and operation of a subway line independent of the Metropolitan system, it was provided that it should extend free transfer privileges to passengers from the Metropolitan at junction points, provided that that company should reciprocate by extending the same privilege to the passengers of the North-South Co. The Metropolitan Co. had opposed the granting of a concession to the North-South Co. and was naturally not disposed to grant a free exchange of transfers. It argued that it would be unfair to a system of some 80 km. of line to exchange transfers with a system of but 10 to 15 km. of line. When, however, the Metropolitan Co. came to the city in December, 1907, asking for certain extensions of its system, the question of free transfers between the two companies was taken up and in consideration of the extensions granted the Metropolitan Co. agreed to the free transfer of passengers with the North-South Co.

In an agreement entered into between the city of Paris and the Metropolitan, in 1908, the company agreed to the free transfer of passengers with the North-South Co. This agreement provided that each company should keep the fares collected by it, except that in the case of the 20-centime round-trip tickets, the receipts from each ticket were to be divided as follows: 9.5 centimes to the North-South Co.; 7.5 centimes to the Metropolitan; 3 centimes to the city. This amounts to an equal division of receipts between the two companies, allowance being made for the difference in the payments to the city that the two companies are required by their concessions to make. The Metropolitan system being owned by the city, that company is required to pay the city a much larger amount than the North-South Co. It was provided that this arrangement could be revised every five years at the request of any of the parties. It was found, however, that this arrangement would be satisfactory neither to the Metropolitan nor to the city. As to the single-fare tickets, there was no difference of opinion, it being agreed that each company should keep the fares received by it. The round-trip tickets, however, offered a special difficulty. These round-trip tickets must be purchased before 9 a. m., and must be used on the day of issue. The lines of the two companies are so located that it is estimated that there will be a large number of passengers that will buy round-trip tickets each morning on the North-South system, and reach their place of business by transfer to the Metropolitan system. Returning they will use the return half of the ticket and thus pay nothing at all to the Metropolitan system. It was estimated, also, that the number of persons who will buy their round-trip tickets on the Metropolitan system and transfer to the North-South system is comparatively small. This plan of free transfers on round-trip tickets would therefore result in loss both to the Metropolitan and to the city, as the city receives one-quarter of each round-trip fare on the Metropolitan system, but only a very small proportion of such fare on the North-South system. The agreement of 1908 was therefore amended in 1909 with the consent of the North-South Co., so as to provide that each company shall keep the round-trip as well as the single-trip fares collected, but in order to reimburse the city and the Metropolitan Co. for loss due to the round-trip tickets, the North-South Co. shall pay the city 200,000 francs (about $38,600) a year, of which 150,000 francs shall be paid by the city to the Metropolitan Co. In order to secure the assent of the North-South Co. to this agreement, it was necessary for the city to consent to an extension of the franchise term of the North-South Co. to Jan. 30, 1950. This is very nearly the date of the expiration of the franchise of the Metropolitan system.

COMPENSATION.—The city of Paris receives for the lease of its municipal subways 5 centimes (1 ct.) on each 15-centime second-class ticket and on each 20-centime round-trip ticket and 10 centimes on each first-class 25-centime ticket. The agreement of 1898 provides that if the number of tickets sold exceeds 140 millions a year the payments to the city on each ticket sold in excess of 140 millions is increased as follows:

One-tenth of a centime for the first 10 million of tickets sold in excess of 140 millions.
Two-tenths of a centime for the second 10 million of tickets sold.
Three-tenths of a centime for the third 10 million of tickets sold.
Four-tenths of a centime for the fourth 10 million of tickets sold.
Five-tenths of a centime for the fifth 10 million of tickets sold.

Beyond 190 millions of tickets sold the supplemental payments cease to increase and will be for all tickets exceeding 190 millions, five-tenths of a centime in addition to the primary charge. Consequently, for any excess over 190 millions of tickets sold the payments to the city for such excess will be as follows: 5½ centimes on each second-class single or round-trip ticket and 10½ centimes on each first-class ticket. The city does not receive any payment on the special tickets sold to school children at 5 centimes (1 ct.) each.

As a result of the supplemental agreement entered into in December, 1907, the payments to the city after Jan. 1, 1912, will be at a rate not quite as high as that indicated in the above schedule. This change was made in consideration of certain obligations assumed by the company in relation to extensions and transfers. The change will make a difference of $60,000 a year in the revenue that the city will receive after Jan. 1, 1912. The change merely substitutes 200 million and 250 million in place of 140 million and 190 million of tickets sold as the limits for the imposition of the increased rates in the above schedule.

In 1909 the total number of tickets sold was 254,445,992. The company paid the city 14,677,569 francs ($2,832,770). The average number of miles of road operated during the year was 54.4 km., which is about 45% of entire system authorized. Until the entire system is in operation it will be impossible to know definitely the relation of the compensation received by the city to its expense for interest and amortization on the cost of construction. From present indications there is little doubt but that the compensation paid will more than cover this charge. Three city bond issues have been authorized; the first of 165,000,000 francs in 1898; the second of 170,000,000 francs in 1903 and the third of 45,000,000 francs in 1908. It was estimated in 1908 that an additional issue of 170,000,000 francs would be required. This would make a total of 550 millions (about $106,150,000). The first issue of 165 millions was authorized at a rate amounting for both interest *and amortization* to not exceeding 3%; the second issue of 170 millions at a rate not exceeding 3½%, and the third issue of 45 millions at a rate not exceeding 3¾%. These rates are exceedingly low. The annual charge necessary for amortization is kept down by spreading the total over the long term of 75 years. This is much in excess of the term of the lease. The company's lease expires 35 years from the date of completion of the entire system. In New York City the subway lease provides for the payment of an amount sufficient to pay interest and amortize the entire cost of construction by the expiration of the term of the lease, 50 years. In Boston as in Paris the term of the lease and the term for amortization of the cost of construction are not the same. The Tremont St. subway is leased for 20 years at a rental estimated to be sufficient to pay the interest on the 40-year bonds issued for construction and provide a sinking fund sufficient to pay off the bonds at maturity.

The basis of compensation provided in the lease of the Metropolitan differs from that of the Boston and New York subways. In Boston and New York the cost of construction is definitely fixed as the basis for compensation. The company pays interest and sinking fund charges on the actual cost of construction. In Paris the company pays a certain amount on each ticket sold which the city *estimates* will be at least sufficient to pay interest and amortization charges. The method under which the Paris subways are being constructed gives to the basis of compensation adopted certain advantages. A comprehensive system of subways was planned. Some of the lines were to be constructed immediately; others at subsequent dates. The plan as first outlined has been added to from time to time. The city makes the detailed plans and lets contracts for construction of the various lines from time to time. The city has every inducement both to construct the lines as economically as possible and to so plan them that they will carry the maximum number of passengers. This results from the fact that the city pays the cost of construction and must rely on the payment of a fixed amount on each ticket sold to make good its outlay.

FRANCHISE TERM.—As to franchise term, the Metropolitan system is divided into three subsystems. The franchise term for each sub-system runs for 35 years from the time of the completion of its last section. The first sub-system was completed in March, 1908, and the second sub-system in December, 1909. It is estimated that the third sub-system will be completed within five years. The lease of the third system will accordingly terminate a number of years after the termination of the lease of the first system. To avoid any disorganization of the system as a whole, the concession provides that the company shall continue to operate the entire system until the day when the third sub-system reverts to the city; but in such case the company shall pay the city an additional annual rental of 45,000 francs per kilometer of double

*Révérard. Des Conditions d'Exploitation du Chemin de fer Métropolitain de Paris, pp. 212-213.

track for all lines the leases of which have expired.

REVERSION TO THE CITY.—At the expiration of the term of the lease, the railway reverts without payment to the city. This is true not only of the tunnels, viaducts and other structures constructed by the city but also of the tracks, electrical equipment, power-houses* and repair shops constructed at the expense of the company. The real property reverting to the city does not include the offices of the company, shops for construction of cars or equipment or property purchased to secure station entrances.† In order to safeguard its equity the city has the right, during the last five years of the lease, to appropriate the revenues of the system and to employ them to put the tracks and equipment in good condition, provided the company should not have satisfactorily performed this obligation.

The city also has the right to acquire at a price to be fixed by arbitration the real property above excepted and the personal property of the company, such as rolling stock, station furniture and tools. The city may purchase such property in whole or in part. The price will be determined by a commission of experts, one of whom will be appointed by the city and one by the company. In case these two are unable to agree, they will designate a third expert. In case they are unable to agree as to such designation, the third member will be appointed by the President of the Council of the Prefecture of the Seine. The price of the property taken must be paid within six months. If the arbitration as to price has not been completed, at the time of the expiration of the lease, the city may nevertheless enter into the possession of the property and use it in the operation of the road. The city may be required by the company to take over any existing stock of supplies at a price to be determined by arbitration as above.

The above conditions for the reversion of the Metropolitan system to the city at the expiration of the term of the concession follow very closely the clauses of the model concession applied generally to street railway undertakings in France.

MUNICIPAL PURCHASE.—The city has the right of purchase at any time after the expiration of seven years of operation of the entire system. In the case of the Metropolitan this will be seven years from the time of the completion of the third sub-system, which system may be completed some fifteen years subsequent to the opening of the first line in 1900. The purchase price will be based on the net profits of the company during the seven years prior to purchase. Of these seven years, the two years having the least profits are first omitted and the average net profit for the other five years computed. This average net profit is fixed as the amount of the annuity that the city is required to pay the company during the remaining years of the lease. The amount of this annuity shall not be less than the net profit of the last of the seven years taken. This annuity will be reduced proportionately to the length of the subsystem or systems that shall have already or shall thereafter revert to the city at the expiration of their respective lease terms. This annuity covers not the entire property of the company but only such property (tracks, equipment, power-houses, repair shops, etc.) as would revert without payment to the city at the expiration of the lease. In addition to the annuity, the city must pay for the rolling stock and other personal property of the company at a price to be determined by arbitration in the same manner as that provided for the taking of the same property at the expiration of the concession.‡ Real property of the company that does not revert to the city at the expiration of the concession, such as offices and shops for construction, may also be purchased at a price to be determined by arbitration.

The city, however, desired to have a right to take over the Metropolitan in 1910, in which year the franchises of a large portion of the surface lines in Paris and its suburbs would expire. As only a part of the entire system would be completed at that time a somewhat complicated system had to be devised in order to safeguard the interests of both parties. If, therefore, municipal purchase had taken place in 1910, the amount of the annuity to be paid by the city would have been fixed as follows: The system in operation would have been divided into two parts—the first part to include the first sub-system; the second part to include all other lines in operation at the time of purchase. A special annuity would have been established for each of these two parts. For the first part the annuity would have been the average net annual profit per kilometer of track earned by this part from the opening of its first section up to the date that the first line of the second part was put in operation. The annuity of the second part would have been the average net annual profit per kilometer of track earned by the entire system from the opening of the first section up to the time of purchase. In neither case, however, would the annuity have been less than the net profit of the last year considered nor in any case exceed 45,000 francs for each kilometer of line operated. The sum of these two annuities would have constituted the amount to be paid by the city to the company during each of the remaining years of the concession. The annuity payable would have been proportionately reduced upon the expiration of the franchise term of the first and second subsystems. For portions of the systems in construction and not yet turned over to the company for operation at the time of purchase, the company would have had a right to reimbursal for its works constructed with a view to such operation together with a bonus of 10%. The company would have been reimbursed for rolling stock, personal property and real estate which does not revert to the city at the expiration of the concession at a price to be determined by arbitration. The annuities payable by the city might have been paid off at any time by paying their aggregate amount less discount at the official rate in the Paris market at the time, but this rate of discount might not be greater than 3%. Though purchase did not take place in 1910, the above provisions for purchase may be taken advantage of at any time subsequent to 1910 and prior to seven years from the opening of the third sub-system, when the first mentioned terms of purchase become applicable.

The basis of compensation in case of municipal purchase (prior to the expiration of the concession) provided for the Metropolitan is substantially that provided in all street-railway concessions in France. The company must rely on its net receipts to pay interest and profit on capital invested and to amortize such portions of its investment as revert without payment to the city at the expiration of the term of the concession. If, therefore, the city in taking over the road pays an annuity equal to the average net receipts and in addition buys at a fair valuation the property that it would have to buy at the expiration of the term, the equities of the two parties are substantially preserved. An objection from the standpoint of the city is that this method of purchase requires the city to buy back the value of a franchise that it has granted free of charge. If the company is earning excessive returns the city in order to purchase will be required to pay an excessive amount. A remedy for this difficulty would be to provide, in the granting of the concession, for the sharing of all profits in excess of a certain rate between the company and the city. If the proportion going to the city is made to increase progressively with the profits of the company, the company will not earn an exorbitant profit and the limited franchise value resulting may be said to have been justly earned by the company and should be paid for by the city in case of municipal purchase prior to the expiration of the franchise term.

LABOR CLAUSES.—The concession imposes many conditions on the operators of the Metropolitan in favor of the employees of the road. Wages must be paid semi-monthly and a minimum wage of 150 francs ($29) a month is prescribed. Temporary employees must be paid a minimum of 5 francs ($1) a day. A 10-hour workday is prescribed. Each employee must be given one day or two half days of rest each week, and also an annual vacation of 10 days with pay. Employees must be paid during absence on military duty.

The company is required to create a special fund for the relief and insurance of employees in case of sickness and accident. This fund is to be administered by the employees themselves and will cover expenditures for the following purposes:

(1) The establishment of a free medical and dispensary service.

(2) The insurance of employees against accidents.

(3) The payment of the wages of an employee during absence on account of sickness. Payment during duly authenticated sickness shall continue for at least a year.

(4) In case of an accident causing temporary incapacity, the employee will receive his wages until complete recovery and without prejudice to the indemnity that would be due him in case of total or partial incapacity.

The company may not retain any portion of the wages of the employees to defray any part of the expense of accident insurance. The company is obliged to insure its employees in the National Pension Fund. Payments to this fund must equal 8% of the wages, one-fourth of which is to be deducted from the wages paid and the other three-fourths paid from the receipts of the company. It was provided, however, that when the number of passengers transported should exceed 220,000,000 per year, the proportion paid by the company would be increased from three-fourths to seven-eighths and consequently the higher proportion is now in force.

The above conditions stipulated in favor of the employees of the Metropolitan were far in advance of any existing labor clauses in the laws or franchises of France. The stipulations limiting hours of labor and fixing a minimum wage aroused considerable opposition. They were not opposed by the Metropolitan Co. but were opposed by the state authorities on the question of adopting the law declarative of the public utility of the Metropolitan Railway. It was argued that the proposed clauses were not in harmony with the general laws of the state and that if they were desirable they should be enacted by general rather than special law. The law declaring the public utility of the enterprise accordingly abrogated the clauses in relation to restriction of hours of labor and a minimum wage. The Metropolitan Co., however, informed the City Council that it considered itself morally bound by these stipulations and would carry them out regardless of their abrogation by Parliamentary Act. The two clauses in question have now no practical significance, owing to the adoption of general laws upon the subject. Aug. 1, 1899, a law was passed permitting cities to require the payment of a minimum wage on public work, and a law of March 31, 1900, has fixed a maximum day of ten hours for all industries. (See Reverard, Des Conditions d'Exploitation du chemin de fer Metropolitain de Paris, pp. 239-249.)

The last report of the company states that its fund for relief and insurance of employees amounted Dec. 31, 1909, to 3,219,974 francs ($621,454.) The same report states that the company has continued to encourage the construction of homes for its employees. Up to Dec. 31, 1909, it had loaned for this purpose 509,606 francs for the erection of 86 houses. The money is loaned partly at 2½% for 12 years and partly at 3% for 20 years. Jan. 21, 1910, the company organized a housing association (Societe anonyme d'Habitations a bon marche de la Compagnie de Chemin de fer Metropolitain de Paris). The

*The company at present owns one power-house and also purchases power from a subsidiary company. It proposed in this way to partially nullify the franchise provision for the reversion of the power-houses to the city at the expiration of the lease. The matter has been compromised in a supplemental agreement of Oct. 29, 1907.

†Easements for entrance to stations must, however, revert to the city.

‡See above under Reversion to the City.

object of the association is the construction of cheap and sanitary houses for the employees of the company. The capital of the association is 500,000 francs, on which it may not declare dividends in excess of 3%. The Metropolitan Co. has subscribed to 4,785 out of the 5,000 shares of the association.

LAWS AND REGULATIONS.—The operation of the Metropolitan is subject to the following general laws, ordinances and decrees:

(1) The law of July 15, 1845 (loi sur la police des chemins de fer), and the ordinance of Nov. 15, 1846 (Ordonnace portant réglement sur la police, la sûreté et l'exploitation de chemins de fer), as modified by the decree of March 1, 1901, form the general basis of regulation and supervision of all railways, the Metropolitan included.

(2) Being a railway of local interest it is subject to the provisions of the general law of June 11, 1880 (Loi du 11 Juin, 1880, relative aux chemins de fer d'intérêt local et aux tramways). In accordance with Article 38 of the above law the President of the Republic on the recommendation of the Minister of Public Works issued Aug. 6, 1881, a decree supplementing and carrying out the provisions of the law. This decree has been amended at various times and was last revised in 1907.

Besides the above general laws and regulations the Metropolitan is subject to the following special laws and regulations:

(1) Concession granted by the City of Paris to the operating company, Jan. 27, 1898. This concession consists of two parts (a) a formal agreement (convention) between the city and the company, (b) detailed conditions and stipulations (cahier des charges) annexed to and made a part of the above agreement. The stipulations annexed follow so far as appropriate the uniform clauses contained in the model tramway concession (cahier des charges type des tramways).

(2) Law of March 30, 1898, declarative of the public utility of the Metropolitan railway. This is a special law modifying and confirming the plans for construction and operation as contained in the concession granted by the city to the operating company.

(3) Supplemental laws declarative of public utility of the various lines of the third sub-system: May 22, 1902; April 6, 1903; Feb. 26, 1907; July 31, 1909, and March 30, 1910.

(4) Ordinance of the Prefect of Police of Aug. 3, 1901, concerning the operation of the Metropolitan railway. This is a most comprehensive and detailed regulation for the operation and supervision of the road in interest of public health, safety and order.

SUPERVISION.—The public supervision and control of the Metropolitan is divided between two authorities: (1) the Prefect of Police, (2) the Prefect of the Seine. These two authorities are subject to the control of the Minister of Public Works.

The control exercised by the Prefect of the Seine is contractural; it results from the terms and conditions of the concession. It is his duty to see that the company obeys the stipulations of the concession. His control is also limited by the concession; he can enforce its terms but he cannot alter or supplement them in any way.

On the other hand the control exercised by the Prefect of Police is broad and general. It is his duty to take such measures and make such regulations as are in his judgment necessary in the interest of public order, health and safety. In case the company considers the requirements of the Prefect unjust its only recourse lies in an appeal to the Minister of Public Works, or on the ground that the Prefect has exceeded his jurisdiction an appeal to the Council of State.

DISTRICT SERVED AND METHOD OF OPERATION.—Paris is roughly circular in shape. Its boundary wall forms roughly a circle having a three-mile radius and a center that coincides with the center of the business district. The area of the city proper is 31 sq. mi. Outside of the city boundary wall there is a large population that may be considered a part of the Paris Metropolitan District. Greater Paris may be said to cover the entire Department of the Seine, which has an area of 185 sq. mi. The population of the City of Paris in 1908 was estimated at 2,790,000, while the population of the Paris Metropolitan District was estimated at 3,960,000. The subway system serves only the inner district or city proper. All the lines are of double track, with stations from 1,400 to 2,000 ft. apart, the average distance being about 1,640 ft. All the trains stop at all stations, there being no express service. The Metropolitan system, as first proposed, contemplated physical connection and through routing of trains over the various lines of the system. This plan was so modified as to make each line independent and self-contained. There is no through routing. Each line is operated on the shuttle plan. The trains run back and forth from one end of the line to the other, usually turning at each end by means of a short loop. It was decided that any system of through routing on the involved network of the Metropolitan would seriously complicate both construction and operation. The free transfer of passengers is, however, permitted at all points of intersection. The average speed on the Paris subway is between 20 and 22 kilometers per hour (12.4 to 13.6 mi. per hr.). The maximum speed allowed under the Police ordinance is 45 kilometers (27.9 mi. per hr.). The trains do not run between 1 a. m. and 5.30 a. m. During 1909 the least headway during rush hours on any line was 2 minutes and 36 seconds and the greatest headway on any line during the period of least traffic from 8 a. m. to 1 p. m. was 9½ minutes. A usual headway for non-rush hours is 4 to 5 minutes.

CARS AND SEATS.—On the Paris Metropolitan subway the maximum capacity of each type of car is determined by the Government. Government regulations contemplate that each passenger, whether standing or sitting, shall have a minimum floor area about 1½ × 2 ft., or 3 sq. ft. This allowance, together with necessary allowance for exits and fixtures, gives in practice one passenger place for approximately each 3½ sq. ft. of floor area. Various types of cars are in use, from the small, old-type motor car, with 20 seats and 15 standing places, to the modern second-class trailer car, with 37 seats and 45 standing places. A large proportion of the cars have 26 seats and 30 standing places. For all cars in use in 1908 the average number of seats was 28 and the average number of passenger places (seats and standing room) was 64. The Government regulations limiting the standing load are not always enforced.

PARIS METROPOLITAN SUBWAY SYSTEM: RESULTS OF OPERATION 1900-1909.

Year.	Average length of line operated, kilometers.	No. of fare passengers.	Gross receipts from operation, francs.	Net income, francs.* Total.	Per kilometer.
1900....	5.135	17,660,286	2,694,563	738,066	143,741
1901....	13.329	55,882,027	8,348,286	1,740,504	130,580
1902....	14.272	72,183,028	10,761,678	2,848,246	199,569
1903....	23.442	118,201,772	17,290,839	4,355,967	185,819
1904....	26.037	140,247,228	20,348,955	5,210,111	200,104
1905....	31.754	178,784,767	25,705,949	6,443,748	202,927
1906....	38.136	201,248,162	28,753,348	7,433,923	194,932
1907....	44.338	239,153,972	34,038,990	8,500,384	191,718
1908....	48.543	282,427,235	39,939,846	10,306,535	212,318
1909....	54.414	314,757,360	44,125,048	11,278,778	207,277

*Gross receipts less operating expenses and less annual rental paid to the city. In American units, the net income per mile of double track was $44,600 in 1900 and $64,300 in 1909.

CAPITALIZATION AND PROFITS. — The Metropolitan Co. has a capitalization of 75,000,000 francs in shares and approximately 75,000,000 francs in bonds, or a total of $28,950,000. An additional issue of 75,000,000 francs in bonds has been authorized, it being estimated that this amount will be sufficient to complete the equipment of the entire system. Three hundred thousand shares having a par value of 100 francs each have been issued. Of this number 10,190 have been amortized in the last few years. The amortized shares are called Actions de Jouissance and participate in all dividends declared in excess of 3%. No bonds were isued until 1906. In 1906, 50,000 3½% 500-franc bonds were issued; in 1907, 50,000 4% bonds and in 1908, 57,812 4% bonds. Up to Dec. 31, 1909, 4,499 of these bonds had been amortized. It is apparently the policy of the company to amortize a considerable percentage of bonds each year. This is necessary, as at the expiration of the franchise term the track, electrical equipment, stations, powerhouses and repair shops revert to the city without payment. In 1909 a first dividend of 3% was paid on the entire share capital, with the exception of 10,190 shares that had been amortized. A second dividend of 5% was paid on the entire capital, including the shares that have been amortized (Actions de Jouissance). Following the usual custom in France and Germany the company pays a percentage of net profits as a bonus to its board of directors and managing officers. In 1909 this bonus amounted to 373,726 francs, or 8% on net profits in excess of interest, amortization, legal reserve and a first dividend of 3%.

The financial results have thus far been satisfactory both to the operating company and to the city. With the continuous development of the system during the past ten years the net income per mile of line operated has been well maintained. Thus far the system has not had much competition. The omnibuses and cabs carry a large traffic but the tramway system is antiquated. Most of the tramway franchises expired in 1910, and prior to that date the rehabilitation and development of the tramways had been long delayed through failure to reach an agreement as to the extension of the franchises.

FINANCIAL OPERATIONS, METROPOLITAN RAILWAY CO. OF PARIS, 1909, REVENUE AND PROFITS.

	Francs.	Francs.
Revenue from passenger traffic		44,125,049
Other receipts		712,148
Gross receipts		44,837,196
Operating expenses		18,880,849
Receipts less operating expenses		25,956,347
Payment to city of Paris as rental		14,677,569
Net income of company from operation		11,278,778
Interest receipts		413,654
		11,692,432
Payment to City of Paris under agreement of 1907 relative to power plants	144,327	
Amortization of cost of organization of company	15,000	
A special depreciation account	10,431	
Interest and amortization on bonds	3,204,085	
		3,373,843
		8,318,590
Balance from previous year		146,923
Profits to be distributed		8,465,513
Legal reserve, 5% on profits of 1909 (8,318,520)		415,929
Amortization of 4,280 shares of stock		1,070,000
First dividend of 3% on 289,810 unamortized shares of stock		2,173,575
Bonus to the board of directors and the executive committee, 8% on excess profits (4,659,085)		372,727
Second dividend of 5% on all shares of stock (300,000) amortized and unamortized		3,750,000
Balance to 1910		683,282
Total		8,465,513

ADVANTAGES AND DISADVANTAGES.—The Paris subway system possesses both advantages and disadvantages. It offers universal transfers over a complicated network of lines. The network of subways will form when completed a comprehensive system of rapid transit for the entire municipality. A passenger may travel by it from any quarter of the city proper to any other quarter. A person may enter any subway station with the assurance that for a single fare he can be transported to within walking distance of whatever place he may wish to go within the walls of the city. This is a great convenience to the public and greatly increases subway travel. This unified system has been made possible by a fairly consistent adherence to the principle of relying on a single operating company. The concessions, however, lack a feature that is essential in case of a monopoly, that of control over service. There is insufficient power reserved to compel adequate service. Moreover, there is no provision for future extensions, though this may seem unimportant in view of the apparent completeness of the system. The chief criticism of the Paris system, however, is that it serves only the congested district located within a radius of three or four miles from the business center. It serves the city within the walls but does not extend out into the great Metropolitan district around the city proper. The rapid-transit lines of Berlin, London, Boston, New York and Chicago extend far into the suburban area, thus spreading population and relieving congestion.

PERCOLATION, EVAPORATION AND RUN-OFF IN RELATION TO RAINFALL.—Prof. W. P. Mason, of Troy, N. Y., submits the following note, based on data published in "La Technique Sanitaire," p. 145, 1910:

G. Lidy comments as follows upon the equation

$$P + E + R = R',$$

where P is the percolating water entering the soil; E the water which evaporates directly from the surface; R the run-off, and R' the rainfall.

The latest German value obtained for $P + R$ is .4 to .5 of the value of R', the value of E being at least .8 of R'. These values leave the above equation unbalanced, the first member being larger than the second. Lidy considers that the difference between the two members is caused by an increased value of P due to atmospheric moisture condensed directly in the pores of the soil, from the air which circulates therein. Moisture from such a source is, of course, not a portion of the rainfall. That it may amount to something noteworthy in volume is shown by Lidy's experiments.

Partial Failure of a Tile and Concrete Grain Bin, Ft. William, Ont.

The failure of a portion of the cylindrical wall of one bin in a concrete and tile grain elevator at Fort William, Ont., on Oct. 29, 1910, throws some light on the stability of this particular type of construction under heavy impact load. The bin in question is one of a set in the left-hand section of the large elevator of the Consolidated Elevator Co., shown in the accompanying halftone (Fig. 1). It is built of successive layers of hollow clay tile and concrete reinforced with steel flat bars, as shown in Fig. 2. The main wall, it will be seen from that figure, consists of hollow clay blocks; about 12 ins. high, arranged in horizontal layers on the circumference of the bin, with intermediate layers of channel-shaped clay tile, filled with concrete reinforced with steel. The face is finished with a layer of book clay tile and all blocks are bonded together with cement mortar.

FIG. 1. GRAIN ELEVATOR OF THE CONSOLIDATED ELEVATOR CO., FORT WILLIAM, ONT. SECTION BLOWN OUT OF SIDE OF CONCRETE AND TILE BIN BY FALLING GRAIN.

Each of the end two bins on the water front of this portion of the elevator are joined together with a curved wall which forms a small interstice bin (Fig. 3). It was originally intended to use this small interstice bin as the shipping bin, reserving the large bins solely for storage and under this design the construction of the elevator proceeded, but when the work was well under way it was decided that additional shipping space was needed, and to gain that additional space a conical steel bottom was put in each bin, about 30 ft. from the top, with a spout extending from its bottom into the interstice bin, from which loading to ships could be carried on. This conical bottom consisted of a steel flange plate, placed in the mortar joint between the blocks, with the cone of the hopper bolted thereto.

At the time of the accident, the lower portion of the full circle bin in question was filled with oats for a height of about 25 ft. and the upper portion, resting on the steel bottom, was filled with wheat. Without any warning the side of this bin toward the river burst out and spouted its contents over a boat lying at the dock alongside. The hole which was made is shown in the view (Fig. 1) and from that it will be seen that the tile, with the concrete intermediate layer, was ripped away from the reinforcing rods which held fast in their circumferential band. On Fig. 3 is marked the extent of the hole. The plan there shows that the break did not extend beyond the connection with the adjacent bin.

It is not known whether the bent plates in the mortar joints pulled out first or whether the initial failure was in the joint between these plates and the conical bottom, but as the break occurred only on the outer or unsupported side of the bin, it seems probable that no part of the wall was torn out prior to the bursting caused by the impact of the falling grain. Had the bin bottom in letting go torn out a section of the wall first, grain would have poured through this opening and perhaps slowly ripped its way down the wall. But the testimony of the nearby spectators is that the collapse was sudden and the grain seemed to shoot out of the whole opening as though shot from a gun. That the opening did not extend any lower than it did is due of course to the presence of the oats in the lower bin, a fact that was not brought out in some of the earlier descriptions of the accident. Very evidently the failure was due to the increased pressure on the weakest section of the wall resulting from the compressing of the air under the falling bottom and the impact of the falling wheat.

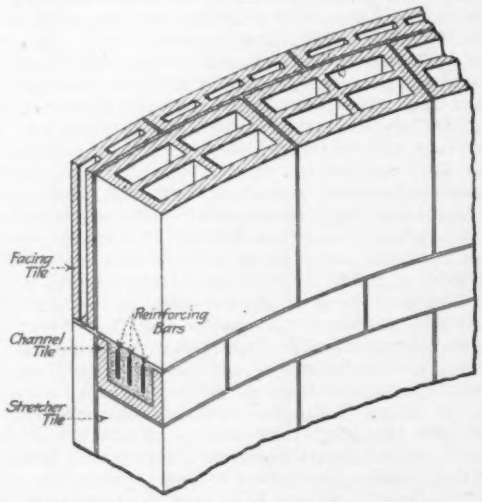


Fig. 2. Isometric View of Wall of Bin.

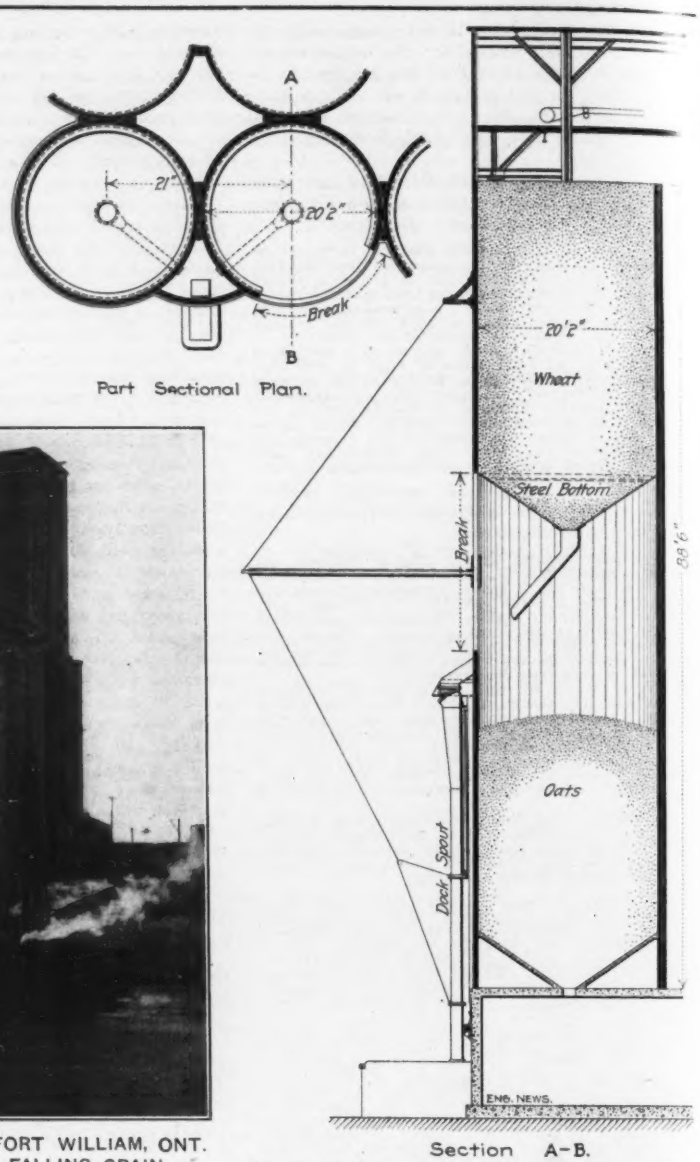


Fig. 3. Details of Bin of Grain Elevator Which Partially Collapsed Oct. 29, 1910.

The hasty design of the bottom probably accounts for its weakness.

This portion of the elevator was designed and built by the Barnett-McQueen Co., Ltd., of Minneapolis, Minn., in 1906.

PARIS AS A SEAPORT.—The revival of the project of the late M. Bouquet de la Grye to deepen the Seine from Paris to Rouen to allow of the passage of sea-going vessels has been one of the most fruitful subjects for discussion during the past month. Singularly enough, the scheme which had until recently always been regarded as a wild dream, is now being accepted as perfectly feasible, and a prosperous future is predicted for Paris as the result of the construction of a ship canal along the river bed. This campaign for converting Paris into a seaport has followed upon the recommendations of the Commission which was appointed to report upon the ways and means of protecting the city from floods. The Commission suggested the construction of an overflow canal to the north of Paris from the Marne to the Seine, and this, together with other works, involved such a huge expenditure that the Municipal Council was only too ready to entertain the alternative proposal of deepening the Seine, whereby it was urged that the flow of the river through Paris would be facilitated, at the same time that the water-borne traffic would be a source of almost unlimited prosperity in the future. It is, however, forgotten that the scheme was many years ago carefully investigated and rejected as impracticable. The objections to the proposal are chiefly the impossibility of raising the 34 bridges between Rouen and Paris, of which ten are railway bridges; the danger of navigating ships along such a winding channel for a distance of 185 kiloms.; the heavy increase in freight, due to establishment and maintenance charges, which would nearly double the present cost of transport by barges; and the certainty of trouble with riparian owners who would object to the bed of the Seine being dredged and dumped down on either side. Furthermore, while the deepening of the river would assuredly prevent floods, the situation in summer would be disastrous, for in times of drought the river would sink into the canal, leaving on either side unhealthy swamps. The Rouen Chamber of Commerce is protesting strongly against the scheme, which is just now appealing to the public imagination in Paris, and the Municipal Council is urged to make a careful inquiry before embarking upon an enterprise which can only become a "commercial disaster."—"The Engineer," London.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
Z. P. MARUYA & CO., Ltd., TOKYO, JAPAN

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An account of the way in which Paris has handled and is now dealing with rapid-transit subway problems is given elsewhere in this issue. The story, which is told in considerable detail, will be welcomed, we feel sure, by all who are following the great municipal developments of the day. It should be of particular interest to New Yorkers, in view of the vast rapid-transit extensions now under consideration and the many associated franchise and contract problems to which the proposed extensions have given rise.

Both the physical and the governmental conditions governing rapid-transit subways in Paris differ greatly from those which prevail in New York. Nevertheless, it is interesting to note that the Paris authorities early decided in favor of monopoly rather than competitive service; but, having decided that much they laid out a comprehensive system designed, as was then thought, to meet the needs of the whole city. This done, and municipal construction with private operation having been decided on, construction plans were drawn, a form of lease prepared, and bids *preparatory to private negotiation* were invited. Of six bids received, two were at once thrown out as undesirable, and later two more were dismissed as not meeting the needs of the case. Finally, a choice was made between the two remaining competitors and a contract was entered into by the city and approved by the national authorities. Only a little more than a year was sufficient for the securing and winnowing of proposals, the award and national ratification of the contract, but all this had been preceded by the preparation of general plans.

It may be noted, in passing, that while the city authorities decided on private rather than municipal operation of the Paris rapid-transit subway system yet the vote was close and would probably have been for municipal operation had it not been for fear of veto by the national authorities. The concession, however, makes provision for an early possible taking over of the railway by the city, on arbitration of the price to be paid for rolling stock, etc.

Paris is paying for its subways by 75-year bonds, although the lease to the operating company is for 35-year periods from the completion of each of the three sub-systems into which the whole enterprise has been divided. The company pays the city a considerable portion of the fares collected (a total of $2,832,770 in 1909). In addition the contract ensures to the employes of the company's minimum rates of wages, free medical service, sickness allowances and accident insurance.

Although the original contract was based on the idea of a single railway system, a concession was subsequently granted to another company. This, however, was for a North-South line, which in some respects was not strictly competitive, and provision was made for transfers between the systems of the two companies. Moreover, the new company agreed to build its entire system without cost to the city and to turn over its subway to the city on the date of the expiration of the lease of the city-owned subway to the other company.

Although Paris was so expeditious with its first or leasing contract its negotiations with the second company extended from 1899 to 1905.

These and many other features of the Paris rapid-transit subway contracts and the results that have been achieved under them are set forth in detail in Mr. Whitten's article, elsewhere in this issue. The article is well worth reading quite regardless of the present complex subway problems in New York City, while for those more or less directly concerned in the New York situation it may have some illuminating value.

It would be a remarkable outcome of our national investment in the Panama Canal if after completion it were to be found that a railway across Central America, built for an insignificant fraction of the money we have spent upon the canal, should prove itself able to compete with the canal in handling traffic between the Atlantic and Pacific Coasts.

Some of the older readers of Engineering News may remember that over a quarter of a century ago the late James B. Eads expended considerable time and money in promoting a scheme for a ship railway to carry ocean vessels between the Atlantic and Pacific across the Isthmus of Tehuantepec. Eight or ten years ago, the route on which Eads proposed to build his ship railway came to the attention of an enterprising Englishman, Sir Weetman Pearson. In cooperation with the Mexican Government, he set about the construction of a railway from coast to coast and the provision of safe and commodious harbors and traffic facilities at each terminal. On Jan. 1, 1907, the Tehuantepec Ry. was opened to the world's traffic. In the first six months of its operation, it handled a traffic valued at about $11,000,000. In the year ending June 30, 1908, this grew to over $31,000,000, and in the year ending June 30, 1910, this became $69,000,000. Compared with these figures, the business done by the Panama R. R. is very small. In 1906, before the Tehuantepec Ry. was opened, the Panama R. R. handled a little less than $6,000,000 of commercial freight. In 1910, it handled about $13,000,000, or only about one-fifth as much freight as took the route lying farther north.

It will be seen from the above figures that the Tehuantepec route has not diverted traffic from the Panama route. The traffic which has sought the Tehuantepec route is traffic which formerly went by the long sea voyage around Cape Horn, or which took the long railway journey across the United States.

Sugar from the Hawaiian Islands is one very large staple of the Tehuantepec Ry. traffic. The sugar comes by shiploads to the Pacific terminus of the railway, is there transferred to cars and carried across the isthmus to the Atlantic port, Puerto Mexico. There the sugar is again loaded onto steamers which carry it to New York City. On the return voyage, these sugar steamers can make low rates on general merchandise freight, which is taken down to the isthmus, carried across and loaded on the Pacific steamers, which sail up the coast to San Diego, San Francisco and Puget Sound, and after discharging the bulk of their cargo there sail to the Hawaiian Islands for another cargo of sugar.

It may be said, however, that when the Panama Canal is opened for traffic these steamers will abandon the Tehuantepec route and sail through the canal, avoiding the transfers and the railway haul at Tehuantepec. Perhaps this will actually occur; but on the other hand there are advantages of the Tehuantepec route which make its competition something to be borne in mind in fixing the toll rates at Panama. In the first place, the sailing distance between New York and San Francisco, via Tehuantepec, is 1,172 nautical miles shorter than the sailing distance via Panama. This means about four days shorter duration for the voyage. If we assume that the cost of carrying freight on an ocean vessel is as low as ½-mill per ton per mile, then freight going by way of the Tehuantepec route would save about 58 cents per ton over the Panama route by reason of the shorter ocean journey. It will also save the $1 per ton toll through the Panama Canal, assuming that this rate is the one that will be accepted and ordered by Congress.

To offset this saving, there will be the cost of transferring the freight from steamer to car at one end and from car to steamer at the other end of the Tehuantepec Ry., plus the cost of hauling the freight from terminal to terminal over the railway, a distance of 189 miles. If the railway can be operated at an average freight rate of ¼-cent per ton per mile, the railway freight charge will be 94 cents, and if we assume 25 cents per ton, as a fair average for the cost of transfer at each terminal port, we have a total of $1.44 as the cost which the Tehuantepec route would have to undergo as compared with the additional cost of $1.58 for the route via Panama. Of course, on some classes of freight the cost of transfer would be much greater than the 25 cents per ton just assumed, and such traffic would naturally seek the Panama route. For sugar and bulk freights, however, which can be transferred at a low cost per ton, it looks very much as if the Tehuantepec Ry. would be able to hold its own in competition with the Panama Canal.

In our correspondence column this week, we print a second letter from an engineer appealing for the adoption of automatic stops in connection with railway signals. We also print in this issue the substance of the Third Annual Report of the Federal Block Signal and Train Control Board.

A perusal of that very interesting document makes clear that the design of a successful automatic stop system which shall really produce the increased safety of train movement that is aimed at is far from being a simple task. Hundreds of inventors have been working at this problem for years past; a score or more of them have achieved some degree of mechanical success; and the Board expresses its confidence that practically successful automatic stop systems will yet be produced.

We have at no time denied the need of such systems. Hardly a week passes but some serious accident is reported as a result of an engineer's disobedience to signals. There are unfortunately only too many such object lessons, illustrating the need of something to supplement the indications of the fixed signal beside the track.

But it is one thing to perceive the need and another to supply it. Many of the enthusiastic inventors who have worked on the automatic stop problem have been unfamiliar with railway operating conditions. Others have been balked by difficulty in securing capital to perfect and exploit their schemes.

This latter hindrance is well set forth by the Board in its report; and it calls attention to a field for practical philanthropy that no one as yet has cultivated. That field is the supply of capital for the development of really meritorious inventions of great public importance.

We think it entirely probable that if some philanthropist would come forward with $50,000 to $100,000 of money and invest it in the development of automatic stop inventions under the advice of the Block Signal Board, he might

enormously advance the development of the signaling art and the safety of life and limb on railways. Incidentally, he might eventually reap a handsome profit on his investment, for there is undoubtedly a great field for the sale of a really practical automatic stop system.

It is the common theory that by a "survival of the fittest," the most meritorious invention will be the one that will be successful in enlisting capital. In practice, however, it seems sometimes as if the exact contrary were true. The inventions which one sees heralded in the public press, and in whose enormous future profits the public is graciously offered an opportunity to become participants are almost invariably either delusions or deceptions. The really important inventions and advances are often too technical for the average business man or investor to understand. Furthermore such inventions usually relate to small details that seem unimportant. It is not easy to show for such devices the glowing fixture which is portrayed by the glib promoter of a fake concern.

We would not pass over the report of this Board, however, without pointing out that aiding the development of a successful automatic train stop system is only one part of this Board's work and not, we believe, its most important part. The great bulk of the railway casualties which at present near the American railway record are not due to disobedience to fixed signals, but to other defects in operating methods and appliances. The first and most important thing for the railways to do is to extend the use of the block system, in some form or other, and particularly on the roads where traffic is heaviest, and accidents most frequent. The "time interval" system of moving trains has inherent dangers, which ought to have driven it out of use two or three decades ago. No railway officer of intelligence can doubt today that the space interval system is the only sound system for use on general traffic railways. The first and most important reform is to further its more general adoption, if necessary, by compulsory legislation.

The Preservation of Macadam Roadways.

Highway engineers all over the world in the past few years have been anxiously casting about for some means of reducing the wear, or the disintegration, of macadam roadways and the dust nuisance that has accompanied the widespread use of motor vehicles. Some attempts seem to have been made at random, in the hope of chancing upon some discovery which would solve the problem all at once. Other attempts show the gradual evolution and logical development of methods through painstaking study and experiment. Whatever progress has been made in gaining better broken stone roadways has come slowly and as the result of alining the successes and failures of practical road builders with the studies of the laboratory chemist, physicist and engineer.

Practical and serious attempts at the reduction of wear and the suppression of dust on macadam have now gone along far enough so that we may begin to inquire into the degree of success secured. The work of residential street building and maintenance in the suburban sections of the New York metropolitan district has been carefully examined, accordingly, and an account of the practices developed is printed elsewhere in this issue.

It will be seen that most of the engineers, in the districts visited, seem to feel that methods have been developed which give fair satisfaction, at least under the local conditions met. Diversity of opinion and practice, however, shows that soil, rainfall, run-off, available materials, etc., still have an extreme importance. In all of the districts noted in our review, probably a very few citizens "kick" most of the time about the condition of the roadways, and possibly most of the citizens have strong objections some of the time, even under the greatest measure of success yet attainable. No one admits that the ideal road has been closely approached in every respect, though distinct advance has been shown.

In none of the cases, discussed in our review of practice in and around New York City is an easy method disclosed of building a new road or treating an old one so that it can be left to itself. The burdens of constant watchfulness and expense are emphasized. For purposes of supervision, a faithful and capable executive, preferably an engineer, seems to be necessary and he must have considerable funds available for his work. Neither a good man without funds nor a poor one with plenty can secure results worth mentioning. These demands of watchfulness and expense are the penalty for traveling fast and far at will; they are the aftermath of the automobile.

In this connection, it is worth while digressing to note that apparently in a suburban or similar district, the highway officials must face an annual expenditure of from $500 to $1,500 per mile for road maintenance, if we may judge from experience around New York City. The actual sums will depend on the density of traffic and the degree of satisfaction secured; high figures may be more confidently expected than low ones.

The great advantage of distributing the cost of construction over the life of the roadways through assessment or bonding plans is hinted at in our review. This frees the annual tax-raised funds from such inroads and leaves such moneys for maintenance and depreciation alone. We do not admit for a moment, however, the propriety of issuing long-term bonds against the cost of the road building. Any issue of bonds to run longer than a conservative estimate of useful life is truly objectionable and so is failure to make sufficient annual contributions, from maintenance and depreciation funds, to retire the bonds at the proper time.

The most promising developments in preserving macadam, found about New York City, are in the use of incorporated bituminous binders and in surface applications of asphaltic oils. These findings are not novel, of course, and only in some specific particulars is novelty to be seen.

The use of either tar or asphalt binder in the construction of new, or renewed, macadam has prevented excessive wear and rapid disintegration under the "kick" of automobile wheels, for various terms of years. The objection against tar seems to lie in its uncertainty, and this must be charged up to our inability to adequately describe the characteristics of this binder in specifications, to the failure of engineers sometimes to benefit by the chemist's knowledge and experience, and perhaps to a lack of alinement between practical experience and laboratory data. Mr. J. Walker Smith, City Engineer of Edinborough, Scotland, in a paper reprinted in Engineering News, Sept. 22, 1910, pointed this out and recommended that specifications for tars be worked out by chemists in the employ of municipalities rather than those paid by tar distilleries. However, in this country it is reported, unofficially of course, that when the carefully drawn specifications of competent government engineers and chemists, for the preparation and use of tar have been followed by very interested persons, the results have been mediocre, compared with those from some more or less proprietary mixtures used with equal care.

Fluxed asphalt as a binder seems to be more reliable and longer lived than tar. The objection is in its cost. The use of liquid asphalts, as binder for new or renewed macadam, has been attended with great uncertainty of result. In Essex County, N. J., the County Engineer reports that in following the best advice as to the composition and use of a very heavy semi-fluid oil, no success at all resulted. In East Orange, Staten Island and Bronx Park, New York City, the results evidently were rather better in the end, but still not of the best. Yet the so-called "asphaltic earth," employed with every indication of success in the Bronx, is but a mixture of fine aggregate with liquid-asphalt binder, prepared before laying and rolled cold.

We have said that oil-sprinkled macadam was a promising development. Many will hold, and on good grounds, that it is an expedient, a palliative only. It is hardly to be regarded as true road construction since it is a protective treatment for ordinary macadams made in approved ways. It is, rather, a high grade of maintenance, since it is work that must be done over and over again. It may eventually be displaced, but today some regard it the cheapest effective way of reducing dust and disintegration along residential avenues. The greatest success from asphaltic oils seems to come when more or less of an asphalt-bound dirt mat is built up on top of and adherent to the macadam. For any success from oil sprinkling, great care must be exercised, of course, and its use easily degenerates into a smearing that is vile while fresh and ineffective when old.

The use of a so-called "clay" binder for macadam, in Montclair, N. J., is worthy of note. The "clay" there used is not the slippery mass with which trouble has been encountered elsewhere, but is, rather, a sand containing enough colloidal matter to give it some binding qualities. Comparatively small amounts are used and with other filling. There seems to result a marked bond of the road metal, though of course, not at all comparable with that of a bitumen. The bond has been found sufficient, however, to prevent disintegration, so long as a thin traffic mat is preserved. This mat may completely overlie the more prominent pieces of broken stone or only surround them as a matrix veneer. But in either case the effect seems to be to prevent the concentration of stress beyond the strength of the clay-bound macadam body.

On the Boston Post Road, in Stamford, Conn., by the heavier application of asphaltic oils a thicker and more perfect traffic mat has been secured on top of the road. The macadam of this interurban artery has even less bond than that in Montclair, but it is kept dustless and fairly smooth in this way. Great care is here necessary, however, to preserve the continuity of the traffic mat.

In some places where ordinary macadam has been sprinkled with asphaltic oils, the formation of a very disagreeable slimy mud has been noted after rains. In other places such troubles have been partially or largely prevented according as more or less of certain precautions seem to have been observed. The most carefully-drawn specifications for the composition of asphaltic oils seem sometimes to be of little avail. At other times, where special care and judgment have been used in applying, almost any make-up of asphaltic oils seems to have given good results, especially if attention is paid to the time of the year and to the preceding and following condition of weather. It seems probable, therefore, that even where the composition of the oil can be carefully restricted to known safe and desirable materials, the application cannot be made until the summer season has been well advanced and the dust is fast becoming a menace. Even then the oil is not to be used after a rain until the roadway has reached its condition of maximum dryness. Special care and judgment seems to be indicated with the more shady avenues of travel. These limitations to oiling arise from conflicting demands, as will at once be seen, but the more of such demands that can be simultaneously satisfied, the nearer the ideal will be the result.

These precautions in the use of oil have been found to be just as necessary for success in the surface application of tar preparations.

Tar-bound and asphalt-bound macadams have been judged generally satisfactory in resisting wear under heavy automobile traffic, but the dust nuisance has at best only been reduced and sometimes almost inappreciably. The burden of constant brooming and sprinkling still has to be borne to keep down the dust. There are accompanying disadvantages of these very necessary operations, in the removal of the surface cushion which increases the noise and the rate of wear.

Even regular sweeping and sprinkling is not always sufficient to satisfy public demands, so that some way is often desired of temporarily binding together the loose accumulations on tar-bound or asphalt-bound macadam, as is the re-

sult of oil sprinkling. Even if the future should disclose a safe method, generally applicable to reducing the amount of cleaning and sprinkling, so much attention must be paid to these dust palliatives that in many cases ordinary macadam would probably be sufficiently protected to wear as well as the bituminous-bound.

Finally, the general futility of attempting to lay a surface suitable to residential streets on principal business thoroughfares is partially disclosed in the summary of road practice outside of New York City. At best, the results seem to have been uncertain, and any improvement seems to have been only temporary. Shopkeepers and citizens alike would be more benefited if these experiments with broken-stone construction were generally stopped on such streets and the money spent on the more permanent stone, brick, asphalt or wood blocks, or into some other "city type" of pavement which is known to hold up under incessant traffic and constant cleaning.

The Defeat of the Selden Automobile Patent.

We briefly noted, on page 59 of our last week's issue, the decision of the United States Court of Appeals, reversing the decision of the Circuit Court which was handed down in 1909, affirming the validity of the Selden automobile patent.

The monopoly for a limited term of years which is granted by the patent law of the United States to inventors is used in two ways. It is used properly, to protect the inventor and the manufacturer in the production and introduction of new devices, which, except for the reward which the patent system offered, could never enlist the necessary capital for investment, and could never therefore be introduced.

It is used improperly as a means of levying blackmail. A patent is obtained for an alleged invention and the right that patent gives of bringing suit for infringement is used as a lever to collect royalties and license fees from manufacturers and others who are not really infringing the patent at all but who prefer to pay rather than go to the expense of defending an infringement suit.

Of all the patents which have been thus misused, the Selden automobile patent is doubtless the most remarkable.

The history of the Selden patent may be briefly summarized as follows: Thirty-three years ago George B. Selden was a patent attorney of Rochester, N. Y. He had more or less knowledge of the work which Brayton of Philadelphia had been doing since 1873 in the development of gas and oil engines. The Brayton engine was operated at the Centennial Exhibition in Philadelphia, in 1876, and had become widely known. It was believed by the leading engineers of that day that the Brayton engine was to be the internal combustion engine of the future.

Mr. Selden became impressed with the idea that the Brayton engine, somewhat modified in its form, might be applied to drive a vehicle to run upon ordinary roads. He undertook to build a modified Brayton engine at a machine-shop in Rochester owned by a man named Clement. The engine was a three-cylinder machine, but only one of the cylinders was bored out and tried. A machinist named Gomm worked on this engine for some months from May 11, 1878, but the engine was never made to work successfully. Gomm testified that the engine would never run continuously but would stop after it had run three to five minutes, even when under no load. Its speed was low, only 25 to 30 revolutions per minute.

The work on this engine appears to have been all that Selden ever did toward actually constructing the invention he claimed to have made; but he then proceeded to apply for a patent on his invention. This invention he termed "an improved road engine," and he filed an application for a patent on it on May 8, 1879. The main ideas in his patent specification are set forth in the following quotation:

> The difficulties heretofore encountered in the application of steam to common roads are the great weight of the boiler, engine water and water-tanks, the complicated apparatus necessary to adapt the machine to the roughness of the roads which it must traverse, the necessity of the attendance of a skilled engineer to prevent accidents, and the unsightly appearance of the locomotives built on this plan. I have succeeded in overcoming these difficulties by the construction of a road-locomotive propelled by a liquid-hydrocarbon engine of the compression type, of a design which permits it to be operated in connection with the running-gear, so that the full carrying capacity of the body of the vehicle can be utilized for the transport of persons or goods, and which, by dispensing with skilled attendance and with steam-boilers, water, water-tanks, coal, and coal-bunkers, very largely reduces the weight of the machine in proportion to the power produced and enables me, while employing the most condensed form of fuel, to produce a power road-wagon which differs but little in appearance from and is not materially heavier than the carriages in common use, is capable of being managed by persons of ordinary skill at a minimum of trouble and expense, and which possesses sufficient power to overcome any usual inclination.

It is apparent from the above quotation, as well as from the later history of the case, that what Selden was actually trying to do was to obtain a broad patent which should cover the use of an internal combustion engine as a means of propulsion of any vehicle for use on common roads. Had he really invented and built an operative vehicle of this sort, he would have had no difficulty in introducing it commercially and would have justly ranked as one of the pioneers in the development of the automobile.

Mr. Selden, however, had done nothing of the sort. He had neither built a vehicle nor even made working drawings for one. He had only attempted to build an engine for a vehicle, and this had proved inoperative.

Under these circumstances he determined to play a "waiting game." He foresaw that with the slow progress likely to take place in the development of the internal combustion engine, many years would elapse before it could be successfully applied to driving road vehicles. He therefore kept his patent application in the Patent Office for *sixteen and one half years* before he had it finally issued.

There was, of course, no particular difficulty in doing this. The rules of the Patent Office permit an applicant two years time in which to make reply to the action of the Office upon an application or any amendment thereto. Thus, when the Office took its first action on Selden's application, he waited within five days of two years before he replied to the Office. To the second action of the Office he waited within thirty-three days of two years before replying. To the third action he waited within eight days of two years. Thus, the delays continued for the eight successive amendments which he filed in response to actions by the Office until Nov. 5, 1895, when he finally permitted the patent to be issued.

Meanwhile, however, things had been happening in the field of invention which Selden was aiming to cover by this patent. Benz and Daimler, in Europe, and Duryea and Ford, in the United States, had built operative carriages driven by internal combustion engines. Selden was aware of these inventions and felt that the time had come when his patent could well be issued. He must have been aware also by this time that the apparatus which he had described in his patent of 1879 was far removed from the apparatus which was likely to be practically successful in the coming automobile.

For example, while Selden did not limit himself in the construction of his wagon, he proposed a crane-neck construction for the front of the vehicle so that the wheels could turn under the body. The construction adopted in the successful automobiles of placing the front wheels upon a fork so that they turn independently was something of which he had not conceived. Again, Selden proposed to place his engine directly on the axle. But experience in the early days of the automobile showed that an engine was promptly rendered inoperative by the jarring and jolts from the road when supported on the axle without the intervention of springs.

It must have been equally evident by this time to Selden that he had made also a wrong choice for his engine. The Brayton type of internal combustion engine with its separate air compressing cylinder, had been practically abandoned, and the Otto type of engine was generally recognized as the coming machine.

It was impossible, however, for Selden to change his original drawings or to materially change the language of his specification. He sought, however, to make the application which he had kept alive so many years cover a broader field in engine construction than it had covered as originally filed, and in an amendment to his application, filed on June 10, 1889, he inserted in the specification and in the claims of his patent the term "liquid hydrocarbon gas engine of the compression type." By this change in phraseology, he hoped to include, in the broad monopoly which he sought to obtain, such engines as Duryea and others were using, instead of the Brayton machine, which he had showed in his patent drawings.

After he had had his patent issued, however, Selden found a serious flaw in it as an instrument for effecting the broad monopoly at which he was aiming. He had shown in his original construction a separate air compressing cylinder as was necessary in the Brayton system of operation. He had included, therefore, as an element in each of his claims, the term "compression mechanism." It was clearly evident that with claims so drawn, vehicles using engines of the Otto type, which had no separate compression mechanism, could not be held to infringe Selden's patent.

After the patent was allowed, therefore, by the Patent Office, Selden filed a petition that the patent might be withdrawn from issue in order that he might cancel in the claims the words "compression mechanism," "provided with compression mechanism" and "suitable compression mechanism." Selden alleged that these words were *surplusage*.

The Patent Office, innocently enough no doubt, granted this petition, and the patent as finally issued contained in its first and principal claim as the engine element merely the words, "a liquid hydrocarbon gas engine of the compression type."

The patent issued, Selden set about marketing it. It will be recollected by many of our readers that a dozen years ago a number of concerns were floated with huge capitalizations and attempted to unload enormous amounts of watered stock on the public, on the ground that they possessed foundation patents for the control of the entire automobile industry.

One of these concerns was the Columbian Electric Vehicle Co., to which, on Nov. 4, 1899, Selden assigned his patent.

This company was not particularly fortunate in its financial career, but it attempted to maintain its claim to a monopoly of the automobile field on the strength of the Selden patent and to collect licenses from all builders of automobiles propelled by gasoline engines. By various means, one company after another was induced to take out licenses under the Selden patent, but the methods by which their acquiescence was obtained were rather evidences of shrewd business ability than of the validity of the instrument which was claimed to warrant a monopolistic control.

For example, under the rules of the Licensed Association of Automobile Manufacturers, the members of the Association are entitled to two-fifths of the proceeds of all the royalties collected under this patent. Thus the automobile manufacturer who recognized the validity of the Selden patent by agreeing to the payment of license fees was a sharer in the revenues arising under the patent. This combined with the low rates of license charged naturally induced most of the smaller automobile concerns to take out licenses and join the association, gaining thereby certain other advantages. Some of the larger concerns, however, were treated with even greater consideration. The Winton Co., was prosecuted for infringement of the Selden patent, and all preparations were made by the Winton company to defend the suit. Among other things, the Winton Co. collected a large number of exhibits relative to Brayton's work in

the application of his engine to vehicle propulsion. Before the case was brought to trial, however, a settlement was made by the owners of the Selden patent with the Winton Co. Under this settlement, according to the statements of the attorneys in the case just decided, the Winton Co. received the sum of $50,000, plus a membership in the Association of Licensed Automobile Manufacturers. In consideration of this payment, however, it gave up to the owners of the Selden patent the exhibits and evidence it had collected with reference to Brayton's pioneer work. The inference is very strong that a full exhibit of Brayton's work to the Court would not have conduced to a broad interpretation of Selden's claims.

In view of the above showing, it is little short of amazing that in the Circuit Court, presided over by Judge Hough, a decision should have been given supporting the claim of the Selden patent owners that any form of internal combustion engine used on a motor vehicle was an infringement of their patent. It is fortunate indeed for the cause of sound patent law, and for sound commercial ethics as well, that the Court of Appeals has now reversed this decision and adjudged the Selden patent to be practically so limited as to be of no effect whatever upon the automobile industry of to-day.

The opinion handed down by Judges Lacombe, Ward and Noyes is an able review of the development of the modern motor vehicle.

The court discusses Selden's sixteen years of intentional delay in the Patent Office, with his application. It says that from the point of view of public interest it were better that the Selden patent had never been granted. The theory of the patent law is that the inventor discloses to the public a new and useful improvement, which he has devised, and he receives his monopoly for a limited term of years in return for the benefit which he is supposed to thus confer. The Selden patent was held in the Office so long, however, between the date of its application and its issue, that when the patent was granted it disclosed nothing new.

"While he withheld his patent," says the court, "the public learned from independent inventors all that it could teach. The public gained absolutely nothing from his invention, whatever it was." The court holds, however, that since the inventor, Selden, was within his statute rights in thus delaying the issue of his patent, his patent is entitled to the same treatment as any other patent. "If the statutes and rules permit unnecessary delays," says the court, "they should be changed, but we reject the view that this court owes any duty to relieve against their operation."

In analyzing Selden's claims, the court finds that the carriage described by Selden, including the running gear, the body, the propelling wheel and the steering mechanism, contained nothing of novelty. Likewise, the drive element, including the power shaft and connections, and the intermediate clutch or disconnecting device, contained nothing that had not been previously used in the art. Selden's drawings and descriptions of these elements were in fact mere outline generalities.

The sole feature of novelty, therefore, if novelty there is in the patent, must lie in the engine. The court found, however, that even in 1879, when Selden first filed his application, the application of a gas engine to a motor vehicle was old. In 1860, the Lenoir engine was applied in France to a carriage. The mechanism, it is true, was not commercially successful, yet the mechanical feat was accomplished. An English patent, in 1865 to Mackenzie described the use of steam, compressed air or other motive power for driving an omnibus or carriage. A French patent to Savalle, in 1867, described the application of the Lenoir engine to road vehicles. An English patent to Kirkwood, in 1874, described a gas engine which, among other uses, might "be incorporated in the structure of an ordinary tramway car or other vehicle." Another patent prior to Selden's was issued in France to Rosenwald, in 1877.

The court concluded, therefore, that the combination of a carriage, a driving mechanism and a hydrocarbon gas engine was not novel at the time Selden filed his application. His sole claim of novelty must, therefore, lie in the use of a hydrocarbon gas engine *of the compression type*. But as negativing novelty in this combination, there were the applications which had been made of the Brayton engine to road purposes. In 1874, Brayton used one of his engines to propel a street car on a trial track near Providence, R. I. The car was run back and forth over a half-mile track and up a slight grade. In 1878, also, an omnibus in Pittsburg was run experimentally by a Brayton engine.

The court, therefore, concludes that the Selden claim could not be given a broad construction, but must be limited to the modifications which Selden made in the Brayton engine.

It was claimed by the complainants in the suit that the modifications which Selden made in the Brayton engine were of such a character, and so important to the development of the art, that they should be construed as applicable to the Otto type of engine as well. The court, however, rejected this view. It said in its decision:

> The [Selden] patent does not pretend or attempt to lay down any rule for reorganizing compression engines to fit them for vehicular purposes. It does not say that other kinds of engines than the Brayton type require changes. It does not say that the changes made in the Brayton engine could be made in other engines or that if made, they would fit them for use in motor vehicles. No one could learn from the patent whether the Otto engine could be constructed with an enclosed crank chamber or whether the substitution of the gearing ratio shown in the drawing would increase or diminish its speed. With the patent before a person skilled in the art, experiments, certainly, and invention, not improbably, would have been necessary to determine the steps required to reorganize the Otto engine.
>
> A patent is granted for solving a problem not for stating one. Its description must explain the invention itself, the manner of making it and the mode of putting it in practice. In the absence of knowledge upon these points the invention is not available to the public without further experiments and further exercise of inventive skill.

Finally, the court considered the question whether the Otto type of engine, as developed in the modern automobile, can be considered in any way the equivalent of the Brayton type of engine, described by Selden. After discussing the radical points of difference between the two types, the Court says in conclusion:

> Granting the patent as broad a range of equivalents as its interpretation will permit, and giving due consideration to the degree of invention involved, still we are not able to hold that the Otto improved engine is the equivalent of the Selden engine or that the defendants infringe by employing it as an element of their motor vehicle combination.

LETTERS TO THE EDITOR.

The Apparent Effect of Water Disinfection on Winter Typhoid at Montreal, P. Q.

Sir: I noted in your issue of Jan. 5 the following question: "Will Montreal escape its annual winter typhoid outbreak?" As yet it is rather early to state positively that Montreal will escape the annual outbreaks which have occurred in the past, but because of the remarkably good showing, thus far, it can almost be stated with certainty that Montreal will not be visited by an epidemic this winter. The two water plants, installed under the direction of the Provincial Board of Health, are both giving very satisfactory results and there is no reason why they cannot continue to protect the water-supply of Montreal.

The following morbidity and mortality statistics for the last three months of 1909 and 1910, respectively, show the relative amount of typhoid which existed in Montreal during these periods.

TYPHOID FEVER IN MONTREAL.

	Morbidity.		Mortality.	
	1909.	1910.	1909.	1910.
October	225	68	27	8
November	218	50	19	13
December	706	58	42	8
Totals	1,149	176	88	29

Truly yours,

Jas. O. Meadows,
Sanitary-Engineer, Board of Health
of the Province of Quebec.

Montreal, P. Q., Jan. 10, 1911.

[While not all the difference between the prevalence of typhoid fever in the two periods can be attributed with certainty to the treatment of the water-supply, yet doubtless much credit is due to the disinfecting plants. An illustrated article, describing those plants, written by J. O. Meadows, appeared in our issue of Apr. 7, 1910. The larger of the two plants treated 48,000,000 U. S. gals. per day at an operating cost of 29 cts. per 1,000,000 gals. As the first cost of the plant was less then $6,000, capital charges would add but a fraction of a cent to the cost of water disinfection.—Ed.]

Automatic Stops for Railway Danger Signals

Sir: I have read with interest the editorial comment on page 726, volume 64, Engineering News, Dec. 29, 1910, on the subject of "Automatic Stops to Prevent Accidents to Trains Running Past Danger Signals." The comment was called out apparently by my letter to you printed on the opposite page of the same issue concerning the "South Orange Derailment on the D. L. & W. R. R."

In justice to myself, I desire to add a little to my previous letter: I had no intention in my letter to "proceed to criticise the railway company, etc.," that is to criticise that particular railway company. It is, of course, obvious to anyone who knows anything at all about railroading on the various large railroads of this country that the D., L. & W. is as careful of its passengers and employes as any railroad—probably more careful than the average. The fault, if any, lies with all the steam railways of the country, as none of them use the automatic stops.

Your comments on my letter would seem to imply that I am an "Engineer who is only casually familiar with railway practice" and hence that I have gone out of my sphere in writing as I did at all. There is no railway engineer living or dead who ever learned all there is to learn about railroading, no matter what his experience in that work may have been; and though I have seen service on several railways in the construction, designing, maintenance (including construction, designing and maintenance of signalling installations) and bridge engineering departments, I must necessarily admit that there is lots of room for me to learn more in any or all of these departments. Yet I object to having my letter considered as coming from an engineer with only a casual familiarity with railway practice.

I really believe that the implied criticisms which I made in my letter should be well taken. I did not suggest "the placing of an automatic brake applying device at the danger signal" with the idea of having that the only place for the installation of such a device. My idea would be to have a device which would set the brakes and shut off the power placed at the proper location relative to any and every signal which commands the engineer to set the brakes and shut off the power. As I understand it, any stop signal, whether it be a block signal, a distance caution signal, a danger signal in the immediate vicinity of a derail, turnout, drawbridge or railroad crossing, or in any location, is in itself an order which, when seen by the locomotive driver, orders him at least to stop, look and listen, in fact orders him to stop his train and not proceed until he gets a clear signal.

Inasmuch as no man is infallible and inasmuch as it is possible to make, install and maintain automatic devices which will stop a train when the fallibility of the engineer manifests itself in any of the numerous ways possible, these automatic devices should be used; and if the arrangements of the air pipe lines, etc., on the locomotive or on the train need to be changed in order to have such devices act, these changes should be made and such a device should be employed at any signal as to accomplish automatically what the signal is supposed to tell the engineer to do, provided the engineer fails to obey the mandate given him by the signal. In other words if a signal merely tells the engineer to slow down, the device could be so placed and operated as to automatically slow the train down. If the signal is a danger signal at the brink of a draw-span of a bridge and the signal thereby orders the engineer to shut down at once and stop his train in a minimum distance the device could be so made and placed as to automatically do this.

The railway companies of the country by their attitude toward automatic couplers and compressed air brakes delayed the installation of these devices on their equipment many years after it was recognized that it was possible to install such devices on steam railway trains. Similarly I have reason to believe that the concluding sentence of your editorial comment above referred to hardly concludes the matter properly. You state "it ought to be better understood by the general public that failure to adopt such devices by the railways is not due to either ignorance or neglect, but because the devices thus far invented and tested for general railway use have not commended themselves on the whole as contributing materially to the safety of train movements."

There are many, including myself, who have more than a casual acquaintance with railway matters who will take exception to this editorial statement of yours. To illustrate, there is no doubt that block systems of signaling have proved of value in promoting the safety of train movements, yet not nearly all railways employ block signals. Can the managers of such railways say that their "failure to adopt such devices is not due to either ignorance or neglect"?

It is my opinion that if some one large steam railway company went further and enlarged its block signaling scheme to protect block signals with automatic stops, the other railway companies would soon follow suit. Automatic stops have proved their efficiency on the Boston Elevated Ry., I am reliably informed, which disproves the statement sometimes made that such devices are only fit for use in tunnels; yet so far as I know or can learn no other elevated railway company in Manhattan, Brooklyn, Chicago or any other city aside from Boston (except possibly Philadelphia) has equipped its lines with the automatic stop. Is their failure not due to either ignorance or neglect? Probably not; it is more probable that it is due to consideration of investment, expenses and dividends, counting the expenses on account of accidents along with other expenses in making up the balance.

The utility of automatic stops in connection with block signaling has proven itself of value on the New York Subway express tracks, yet there are no such automatic stops in connection with the signals on the subway local tracks. Are not the lives of subway passengers traveling on the local trains as important as the lives of those on the express trains? Here again the reason must be one of dollars and cents rather than ignorance. In other words it is the saving of dollars instead of lives that must be reckoned with in meetings of Boards of Directors of these large corporations.

In the case of the accident to the D., L. & W. R. R. train at South Orange, which started this discussion, the first signal which the locomotive driver failed to be ruled by was the block signal some half-mile back from the point of derailment. Had the engineer obeyed the mandate given him, he would have at once slowed down the train. Is there any sane man who can rationally object to placing an entirely feasible automatic arrangement either at or near such a block signal so that, if the engineer, because he has to sneeze, or for any reason is not looking and fails to see the signal, which automatic arrangement would then do what the engineer was expected to do, and slow down the train? Wherein would this fail to "contribute materially to the safety of train movements."

Yesterday morning, Jan. 9, so we are informed by the newspapers, a locomotive runner on the D., L. & W. R. R. was killed at or near Harrison, N. J., from a somewhat similar accident to that to which I called attention in my previous letter. In case of the accident yesterday, it was a freight train instead of a passenger train; but, so we are told by the newspaper account, the engineer took an open switch to a siding and was unable to stop his train without destroying the bumper at the end of the track and overturning his engine into the street below, he himself being pinned underneath in such a position that he was scalded to death before he could be released.

As I understand it, the D., L. & W. R. R. at this part of its system is equipped with block signals, so that the block signal next back of this open switch point must necessarily have been against that train movement. Had there been an automatic stop in connection with this block signal, this engine driver's train would necessarily have been stopped before taking the open switch, assuming that the block signal and stop were properly placed for that purpose at the proper distance back from such opening in the main track for a turnout. This is simply another example to add to the one which I described in my previous letter illustrating a preventable accident; that is, an accident that would not have occurred had the D., L. & W. R. R. installed automatic stops in connection with their installation of block signals.

To conclude, I would like to repeat the last paragraph of my previous letter and say that the writer, for one, would like to see some real agitation started which will have the result to persuade or compel steam railroad companies to use some such automatic device as has already proven itself successful on certain electric railways in order to properly safeguard the people patronizing these railroads, and, I might add, to properly safeguard the employees of such railroads.

Wm. M. Torrance,

39 Cortlandt st, N. Y. City, Jan. 10, 1911.

Annual Convention of the Indiana Engineering Society.

The 31st annual meeting was held at the Dennison Hotel, Indianapolis, on Jan. 12 to 14. The program listed 40 papers and reports for the four sessions, and it was perhaps fortunate that not all of this material was presented. The first evening was given up to the annual dinner and the afternoon of the second day was given up to an excursion to the new power plant of the Merchants Heat & Light Co. and to the plant of the Citizens Gas Co. This plant is of interest on account of its use of by-product ovens for the generation of illuminating gas, as described recently in our columns.

Practically all of the state engineering societies devote themselves almost entirely to matters of civil engineering. The Indiana society is one of the few to take up mechanical, electrical and mining work, although this represents but a small part of its program. The report of the Committee on Mechanical Engineering referred to the development of internal-combustion tractors for farm work and heavy plowing. Both gasoline and kerosene engines are being used, but it is much more difficult to design an engine that will work satisfactorily on this latter fuel. The committee recommended, also, that steps should be taken to increase the membership among mechanical engineers.

The report of the Committee on Mining referred to the improved rate of production in many coal mines, due to the use of larger mine cars, electrical machinery, and a greater employment of engineering direction of the work. Where mines formerly produced 1,000 tons now they produced from 1,500 to 2,000 tons. Better and more economical working of the coal may be ensured by a more complete and accurate system of mine surveying. In this connection, the report included what was practically a paper on proper methods of such surveying, by Mr. A. N. Ogle.

The report of the Committee on Materials of Construction (presented in abstract by Prof. W. K. Hatt) deals with specifications for methods of waterproofing concrete, tests of paving brick, and tests of creosote oils. Prof. Hatt presented also a paper on the new cement and concrete testing laboratory at Purdue University. In the cement laboratory, concrete tables and tanks are used. The tanks are cheaper, more durable and of better appearance than other forms of tables. A paper on the manufacture of Portland cement was read by Mr. C. W. Boynton.

The Committee on Drainage presented (by J. S. Spiker) a partial summary of the work in Indiana, computed from information furnished by the county surveyors of 31 counties. It appears that these counties have reclaimed 2,689,700 acres, at an approximate cost of $18,779,500, and that less than 500,000 acres remain to be reclaimed. Mr. E. E. Watts read a paper on the levee system for the protection of a large area of land between the Wabash and Patoka rivers.

In regard to water-supply and sewage disposal, Prof. R. L. Sackett (Purdue University) presented a paper on "Recent Tendencies in English Sewage Purification Plants," and also the report of the Committee on Stream Pollution. This report referred to experiments made at Grand Forks (Dakota) as to the life of typhoid bacilli in streams, which experiments have been described in our columns. They indicate that the bacilli live longer in water covered by ice than in open water, which may explain winter epidemics. He outlined also the conditions of certain Indiana towns on streams whose dry weather flow is but little greater than the sewage discharge.

The report of the Committee on Water Works dealt with the subject of consumption for fire purposes and with the desirability of standardizing hose attachments. Mr. Leisen (Louisville, Ky.) referred to the long continued agitation of the Board of Fire Underwriters upon this matter of standard fittings. He referred also to the desirability of action by the federal government in regard to stream pollution, and remarked that at a meeting of the American Water Works Association he had been surprised to find opposition to such action by the government. In a paper on "The Evolution of a Pumping Station," Mr. Leisen described the station of the Louisville water-works; the original plant consisted of Cornish walking-beam pumping engines (1860), while the present plant consists of centrifugal pumps driven by vertical-shaft steam turbines. A paper on "Wells and Well Pumping Machinery," by Mr. Charles Brossman (Indianapolis) reviewed the development from the earliest historical days to the modern deep well fitted with various kinds of pumping apparatus, including the air-lift and the impeller pump having a screw or impeller placed in the well pipe.

Methods of road improvement were dealt with in a paper by Prof. R. L. Sackett (Purdue University), and this was illustrated by a number of views of improvement work in macadamizing, tarring, dragging, and the construction of burnt clay and sand-clay roads. He also emphasized the necessity of maintaining roads, as railway track is maintained. Mr. Watts (Princeton) favored the use of crusher-run stone in building roads, in preference to a bottom layer of coarse and a top layer of fine sand. The maximum size should be 2 ins. A paper by Mr. J. O. Potter (Muncie) deprecated the idea that farmers do not give a proper time on the road to work out the road tax. His experience was that they gave more than the requisite time, although he did not claim that their work was efficient. More attention should be given to the economics of haulage. A certain road having a very heavy traffic for a distance of about six miles has easy grades except for one short piece of 6%; this could be reduced so that at least ½-ton could be added to each of the wagons, but no steps have been taken for such an improvement. As to construction work there are no standard or uniform methods. In the discussion, the establishment of a state commission to have charge of the roads and highway bridges was advocated.

Prof. Albert Smith (Purdue University) read a short paper on "The Relations of Bridge Specifications to Highway Improvement." This showed the relative weights of bridges of different types for the same span, and also renewed the live-load conditions due to traction engines and road rollers. A paper by Prof. Malverd A. Howe (Rose Polytechnic) outlined some test made a few years ago as to the strength of upsets and welded loop eyes on steel rods in highway bridges. The tests indicated that the average strength of both the loop and the upset is only about 90% of that of the body of the bar. The conclusions drawn were that if upsets and loops are to be used they should be formed as bars of wrought iron (not steel), and that a better construction in every way is to use rolled shapes with riveted connections instead of rods of this type.

A concrete girder bridge of 40-ft. span was described by Mr. F. A. Kattman. This bridge is of the through type. Mr. D. B. Luten took up the cudgels for concrete arch bridges as being preferable to girder bridges. The report of the Committee on Bridges dealt with floor construction and paving of highway bridges. Coverings of brick, asphalt, gravel and creosoted wood blocks were considered; preference was given to the last. The blocks are sometimes laid on a concrete floor, but for steel bridges a plank floor is considered preferable as a general thing.

Statistics of paving in various Indiana cities were presented by the Committee on Roads and Paving, and the design of the standard roller for brick tests, as adopted by the National Paving Brick Manufacturers' Association, was described by Mr. M. W. Blair. The report of the Committee on Railways briefly discussed the grade crossing question (and the problem of elimination versus protection), and presented some statistics as to the railways of the state. Mr. C. A. Tripp (Indianapolis) presented a paper on "Individual Electric Drives in Textile Mills," showing the advantages of this system. A paper by Mr. R. P. Woods described "The Irrigation Project of Portales, N. M." This is a private system with a combination of unusual and interesting features. Power is generated by a producer-gas and electric plant, having three producers and two Westinghouse engines of 750 HP. A 73-mile transmission line is led to a main transformer station, from which current is distributed to 69 pumping plants having centrifugal pumps which draw water from a sub-surface flow.

The election of officers resulted as follows: President, Daniel B. Luten, Indianapolis; Vice-President, Prof. Malverd A. Howe, Terre Haute; Secretary, Charles Brossman, Indianapolis.

An interesting feature in the illustration of the papers by a projecting lantern was the use of the balopticon, in which no slides are required. The original drawing, print photograph, etc., is placed upon a table or plate beneath the machine, and that portion which comes within the area of an opening is reflected into the lantern tube and so thrown upon the screen.

An Electric Steam Boiler.

When the installation of electric traction in a few railroad terminals was undertaken, one of the problems early recognized was that of heating trains while operating them through the electric zone. The installation of electric heaters in each car at the outset seemed entirely impractical, first, because of the number and variety of cars hauled through the electric zone, so that a great deal of apparatus would have to be installed which would be in use only a short period of time compared with the whole length of time which a through car would be in service, say, between New York and Chicago.

When the passenger coaches remain in the electric zone and are connected to the electric locomotive only a few minutes, say, from five to ten, the cooling off of the car itself is not seriously considered. The cooling of the heating pipes, however, must be taken into account for the time consumed in getting steam through the train pipes again has an important bearing on the time required for shifting from electric to steam locomotives at the end of the electric zone. Under present practice, the train cannot start until steam has been blown through the entire length of the train pipe, and this imposes an added delay of from three to five minutes if this train pipe is allowed to cool off appreciably. This is an added necessity for a small steam boiler on the electric locomotive.

Small oil-fired boilers have been tried on the electric locomotives, but they have not given satisfaction because of the creeping of the oil beyond its containers and because of a tendency for such boilers to smoke. Furthermore, the factor of insurance plays an important part, the combination of electric apparatus and a highly inflammable fuel on the same locomotive being regarded with great suspicion by the underwriters.

For several years a wholly satisfactory design of electric steam generator has been sought, but it has been found difficult to secure. Various methods have been devised of generating and applying the heat to the water within the boiler, and a very successful type is seen in the design of the Safety Car Heating & Lighting Co., of New York City, whose engineers have been working on this design for several years. The electric current is taken from the main circuits of the locomotive. The generator is in the form of a vertical tubular boiler, the place of combustion products, in heating the water, being taken by a resistance unit slipped into the tube. The general arrangement is shown in Fig. 1, and the appearance, installed, is shown in Fig. Each heating unit consists of a core of steatite on which is wound patent alloy resistance wire which will withstand high heats without disintegration or oxidization. Details of these heaters are shown in Fig. 2. The element is slipped into a thin brass tube, the resistance wire being held from contact with the sides by porcelain insulators. The space between this heating element and the sides of the brass tube is filled in with a fine silicious sand, which serves to conduct the heat from the resistance wire and also as an electrical insulator. This brass tube is slipped into the boiler tube and makes a neat fit therein. The boiler tubes are expanded into the heaters and the lower end of each is closed with a screw plug, as shown in Figs. 1 and 2. It is seen that the heating element at no time is in contact with the water.

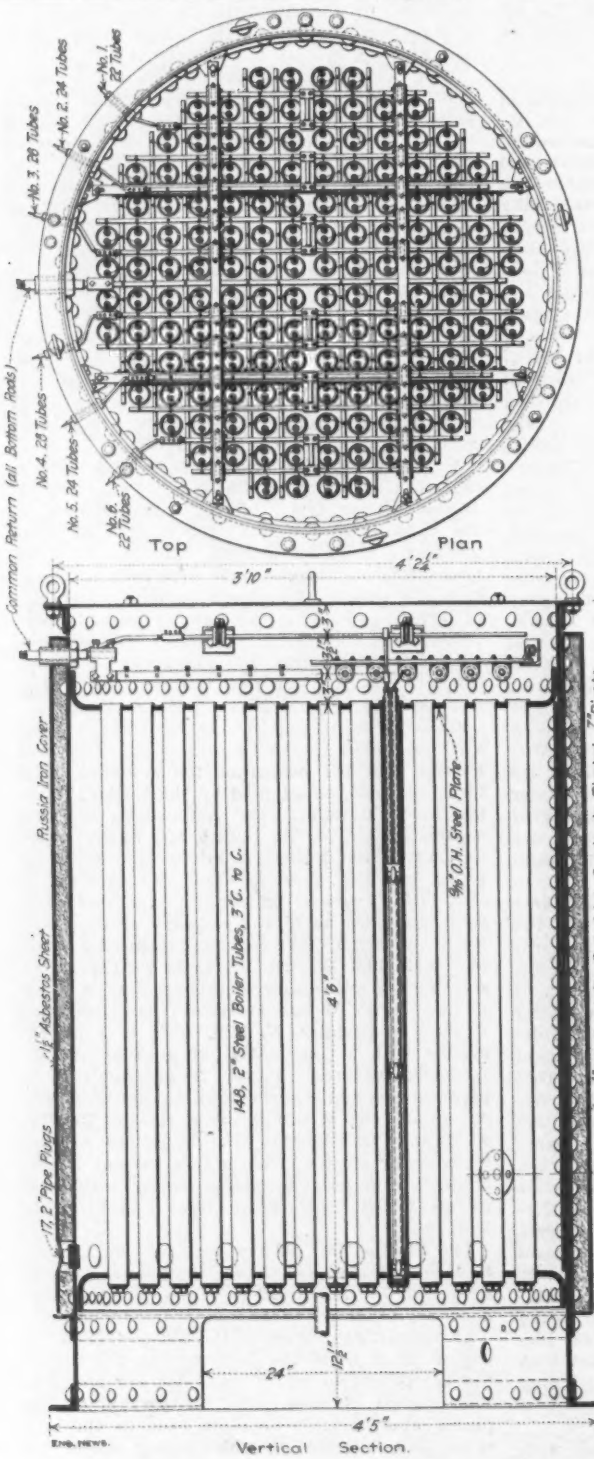

FIG. 1. PLAN AND SECTION OF AN ELECTRIC STEAM GENERATOR.
(Safety Car Heating and Lighting Co., New York City.)

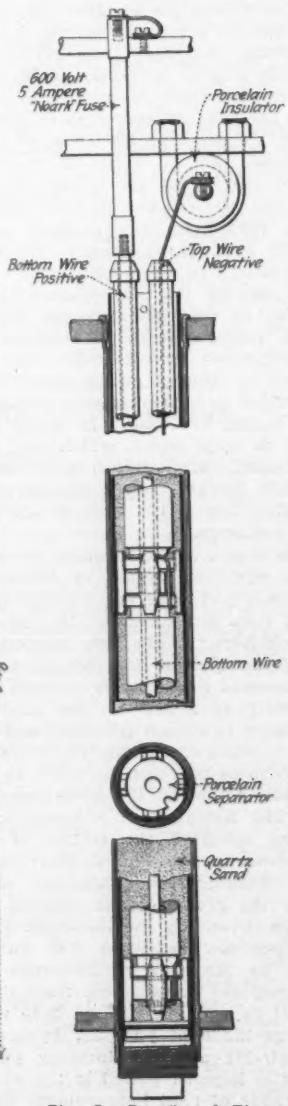

Fig. 2. Details of Element of Electric Steam Heater Generator.

This type of boiler, with 148 tubes as shown, has a maximum capacity, when furnished with current at 666 volts, of 850 lbs. of steam per hour at 110 lbs. gage, corresponding to 1,037 lbs. from and at 212° F. This gives a boiler rating of about 35 HP. on a basis of 30 lbs. of steam per HP.-hr. Tests of a boiler installed in a New York Central locomotive have shown a working efficiency of 91.9% efficiency at 653 volts and 470 amps. Several of these boilers have been installed in the Pennsylvania and New York Central electric locomotives.

Third Annual Report of the Block-Signal and Train-Control Board to the Interstate Commerce Commission.*

At the date of the board's report of last year, plans and descriptions of 835 devices intended to promote the safety of railway operation had been submitted for examination and 511 had been examined and reported upon. During the past year 102 additional devices have been presented for consideration, making a total of 937 submitted to date. Of this number, 819 have been disposed of, leaving 166 cases now before the board for consideration.

The board has also received a mass of correspondence relating to devices concerning which no plans have been furnished. In many cases inventors, mistaking the functions of the board, have presented ideas looking to the development of some form of safety device and have requested the assistance of the board in embodying their ideas in a device that would perform the functions intended in a practicable way. In all such cases the inventors have been informed that their ideas cannot be considered unless presented in the form of plans and specifications showing in detail a practicable device designed to perform a useful function and clearly describing the manner in which that function is proposed to be performed. The board has always endeavored to assist inventors by pointing out defects in apparatus and offering suggestions for improvement, but it cannot undertake to perform the functions of a consulting engineer.

Of the plans examined during the past year 91 covered signal and automatic train-control devices, 103 related to ties, rails, rail fastenings, switches, and other track appliances, 64 were devices relating to the construction and equipment of cars and locomotives, such as couplers, draft rigging, ash pans, headlights, etc., 30 related to adjuncts to the air-brake system and emergency brakes for cars, 9 were mail-bag catching and delivering devices, 7 were automatic hose connectors, and 4 were torpedo placers.

*Slightly condensed from the original.

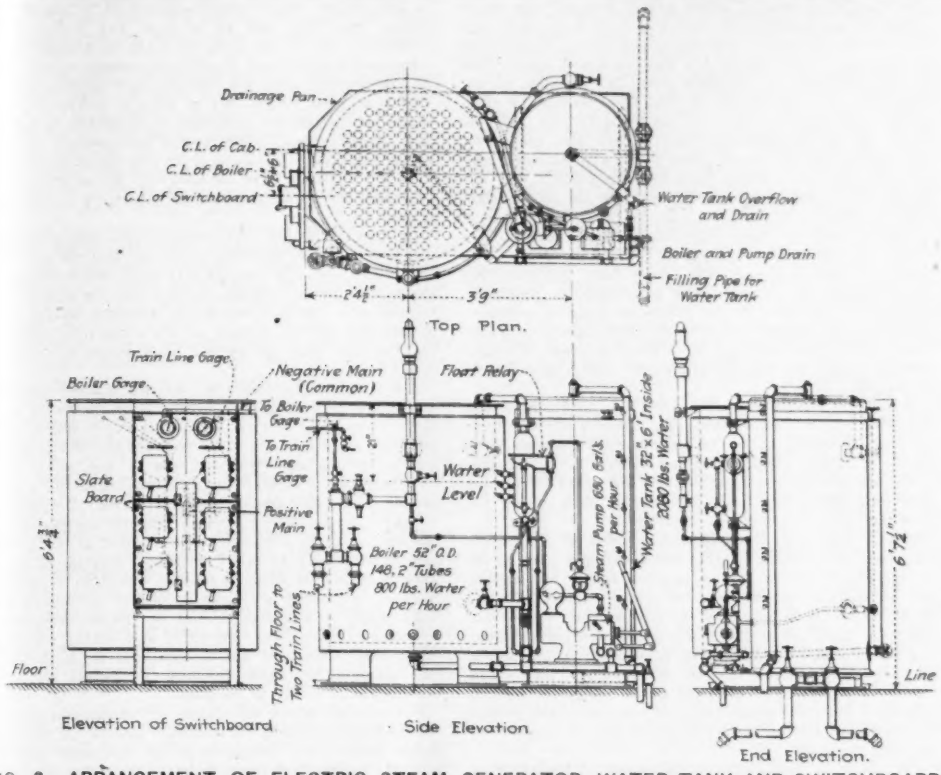

FIG. 3. ARRANGEMENT OF ELECTRIC STEAM GENERATOR, WATER TANK AND SWITCHBOARD IN THE CAB OF AN ELECTRIC LOCOMOTIVE.

Miscellaneous Devices.

HOSE CONNECTORS.—Two automatic hose connectors have been held to possess merit warranting the conduct of practical tests under service conditions, and the board is informed that the proprietor of one of these devices is now endeavoring to procure the necessary equipment for test purposes. As noted in the board's last annual report, automatic hose connectors are now used regularly, but only to a limited extent, and their use still seems to be regarded as experimental. Some of the hose connectors that have been presented to the board for examination possess theoretically good features which would seem to render devices possessing them entirely practicable. One of the main reasons for failure of the railroads to adopt hose connectors, so far as the board can determine, seems to be the failure of manufacturers and designers of connectors to agree upon the specific form of connector contour that will fulfill the requirements of the situation.

In response to a request from the board, the Long Island R. R. Co. has furnished the following information:

At the present time the latest type of automatic heads are running on our passenger-train cars and locomotives with reasonable success. We find, however, that the leakage is much greater than with hand couplers and are of the opinion that there is no saving whatever in the cost of the hose. We are also doubtful as to whether the time saved by automatic connectors justifies their expense in view of the fact that serious delays occur whenever it is necessary to change a gasket after a train is made up.

We consider the use of these connectors still in the experimental stage and are not fully prepared to recommend them for general use.

The Chicago & Alton R. R. Co. advises the board that two of its trains were equipped with automatic connectors some years ago, but that considerable trouble has been experienced on account of leakage, and the company is not contemplating any additional equipment.

The mechanical officers of the New York Central lines report that they have tested a number of different designs of connectors, but that as yet none has been found that will operate successfully under heavy traffic conditions.

BRAKES.—In the field of train brakes no important development has taken place during the year. As previously stated, 30 devices of this character have been examined, but most of these were of such character that their use would introduce complications into the brake system as a whole and destroy its flexibility to such an extent that, even though their intended functions might be satisfactorily performed, their use would probably reduce the efficiency of the brake system as a whole and no increase in safety would be attained.

Two complete brake systems have been presented. One of these, that of the St. Clair Air Brake Co., of Indianapolis, Ind., was treated in the board's second annual report. So far as the board is informed, there have been no new developments in that system during the past year.

The other brake system is that of the California Valve & Air Brake Co., of Los Angeles, Cal. The distinctive feature of this device is that it retains all the advantages of the straight air brake and at the same time permits automatic application of the brakes. The disadvantage of being compelled to release, and thus lose braking power, while recharging the auxiliary reservoirs, as is necessary with systems now in use, is overcome, and the use of pressure-retaining valves is not necessary. In this system braking power is not affected by variations in piston travel or leakages in brake cylinder packing leathers, as pressure from the main reservoir is applied direct to brake cylinder pistons, and is thus not dependent upon variations in volume. Auxiliary reservoir pressure is used only in emergency applications of the brake, the triple valve being so constructed that in such applications the pressure stored in the auxiliary reservoirs flows into the brake cylinder and supplements train-pipe pressure.

This brake is reported to have been used to a limited extent on a western railroad, but the board has not had sufficient information respecting it to be able to pass a definite opinion concerning its merits. Before a final opinion regarding the merit of the brake can be given it will be necessary to test it in trains partially equipped with brakes of the types now in use, under the most severe conditions it is likely to be subjected to in actual service, so as to determine whether or not there will be synchronous action of the several types of equipment.

HEADLIGHTS.—During the past year considerable discussion has taken place in regard to the use of locomotive headlights of high candlepower. In seven States, Arkansas, Montana, North Carolina, Oklahoma, South Dakota, Texas, and Washington, locomotive headlights of 1,500 candlepower or over are required by law; in Indiana locomotive headlights of 1,500 candlepower or over are required by an order of the state railroad commission, and in Georgia the law requires electric headlights with 300 watts at arc and reflectors 23 inches in diameter.

The ordinary oil headlight commonly employed on locomotives is seldom powerful enough or maintained in a condition to make it more than a marker to indicate to persons at stations or railway crossings, or in yards or to trains on other tracks, that an engine is approaching. As a means of discovering or identifying distant objects on the track it has practically no value. The argument in favor of the high-power headlight is that persons or obstructions on the track may be seen by the light of a powerful gas or electric headlight at a sufficient distance to enable the train to be stopped before reaching them. On straight track the high-power headlight undoubtedly affords a degree of illumination, except in snow or fog, sufficient to enable an experienced engineman to distinguish unusual objects on the track at a considerable distance.

As headlights are usually fixed in position, their rays are projected in the direction of the axis of the locomotive, and hence on curves do not illuminate the track ahead. Various devices have been submitted to the board intended to impart to the headlight while the engine is rounding a curve motion to turn its beam so that it will fall on the track. Most of these devices are crude, and attempt to use the curving of the front truck of the locomotive as it passes around curved track to rotate the headlight. It seems unlikely that any apparatus of this kind can be made effective to meet all the conditions of reversed curves, tangents succeeding curves, and variations in curvature, that are found on many railroads, and it is probable that if full advantage is to be taken of the high illuminating power of gas or electric headlights on roads where much curvature exists, any motion of the headlight about its vertical axis must be within the control of the engineman.

Very strong objections are made to the use of high-power headlights, for the reason that the rays are so intense as to impair seriously for several seconds the vision of persons who may look into the beam. This effect, when experienced by enginemen of trains running in the opposite direction on parallel tracks, is considered by many to be serious. It has long been known that after a locomotive fireman has looked into the fire box for even a very few seconds in putting on coal the scotoma which persists for some seconds afterwards makes his reading of signals at night very unreliable until its effect has had time to pass off.

As regards the effect of the high-power beam upon the

Fig. 4. Electric Steam Boiler Installed in the Cab of an Electric Locomotive.

Fig. 5. Switchboard of Electric Steam-Generator Equipment.

vision of the men riding on the engine on which the electric headlight is used, it has been found in some rather extensive tests that the rays were sufficiently powerful to reflect back from the surfaces of the roundels of semaphore signals an amount of light sufficient to overpower the light transmitted by the signal lamps themselves. The spectrum of the electric arc is very rich in blue and green rays and contains a relatively small proportion of the red and yellow; hence, rays from the arc light reflected from the surface of the colored roundel would tend to diminish the resultant proportion of red in the light, and if reflected back from a green roundel would intensify its color.

Very deceptive effects of this kind have been noticed by many observers, and while apparently such conditions may be dangerous as leading to erroneous reading of a signal light, they are largely counteracted by the fact that the high power of the light serves to reveal at a considerable distance the position of the signal arm. The usual rules governing enginemen in their interpretation of signal indications state that the indications will be displayed by day by positions of the semaphore arm, and in addition at night by lights of prescribed color, the effort being made to train the enginemen in so far as possible to depend upon position rather than upon color.

In the case of classification signals—that is, the colored lamps used on the front end of engines to indicate whether the train is an extra rather than a regular train, or whether it is running in two or more sections—the condition is much more liable to cause a misunderstanding of signals for the reason that classification signals are color signals purely, and are not signals of position. So difficult is it to read classification signals correctly when viewed in the beam of an electric headlight that railroads have made strenuous objection to their use on this account alone.

The whole question at the present time is in a highly controversial state. So far as opinion has at all crystalized, it appears to be as follows:

On single-track roads, particularly those in mountainous country or where fixed signals are infrequent, the high-power headlight on a train affords a warning of its approach for a considerable distance, and under favorable circumstances it enables the engineman to distinguish obstructions or unusual objects on the track much farther ahead than is possible with ordinary lights.

On double-track roads, and particularly on roads having three or four tracks and equipped with signals placed at frequent intervals, the prevailing opinion seems to be that the electric headlight is not only unnecessary, but is likely to cause serious errors on the part of enginemen in reading color signal lights.

METAL, CONCRETE AND COMPOSITE TIES.—Various forms of ties composed of material other than wood and designed to improve the condition of railway track, both with respect to economy and to safety of train operation, have been submitted to the board for examination. Important economic questions enter into the consideration of this subject. By the use of wooden ties placed in a roadbed properly ballasted and drained, and with adequate track fastenings, a safe track can be maintained. The main advantage, therefore, to be derived from the use of ties of material other than wood is decreased cost of maintenance and renewal.

In the employment of electric track circuits in railway signaling it is necessary to insulate one rail from the other. An important difficulty with the metal tie is found in the problem of providing proper insulation. Another important matter in connection with the use of both metal and concrete ties is the difficulty of maintaining proper gage and surface under varying climatic conditions. In the winter season, in sections where there is considerable moisture in the ground, freezing causes the roadbed and track to heave, distorting the surface. In common practice this condition is met by blocking up or shimming the rails, or in some cases where short sections of track heave in winter, blocking is used between ties and rails in summer and removed gradually in winter as the ties heave.

Metal or concrete ties cannot be adzed to diminish their thickness nor can holes for bolts or spikes be bored in them at random for altering the relation of the rail to the tie so as to maintain proper gage and surface. This is a problem which must be solved by the design of proper track fastenings. It is believed that the development of efficient devices of this character will hasten the development and more extensive use of metal concrete ties.

Up to the present time the development of concrete ties has not progressed as far as that of metal ties; this is believed to be due largely to the fact that much of the effort in concrete tie construction was made prior to the comparatively recent development of concrete composition, manipulation, and reinforcement. It is probable, however, that when it becomes necessary to use other materials than wood, both metal and concrete will find large fields of usefulness in railway tie construction.

As a number of the ties which have been submitted to the board for examination are now in service, and have been used for a sufficient length of time to disclose their good and bad features and permit the formation of fairly accurate conclusions regarding their practicability, from the standpoints both of safety and of economy, the board appointed a committee, consisting of Chairman Cooley and Mr. Ewald, to make a personal examination of such ties in service. This committee has examined metal ties manufactured by the Carnegie Steel Co., installed on the Bessemer & Lake Erie R. R. and the Baltimore & Ohio R. R.; cast steel ties made by the Metal Ties Co., of New York, on the Baltimore & Ohio R. R.; also the Corell concrete tie in use on the Erie R. R. and on the International Ry., an electric road between Buffalo and Niagara Falls; and the Kimball composite tie on the Chicago & Alton R. R.

SPARK ARRESTERS.—Several of these devices, designed to reduce the danger of fire set by locomotives along railroad rights of way, have been presented for examination. It is practically impossible to determine the merit of a device of this character from an examination of plans; it must be seen in actual operation under the most severe conditions it is likely to meet in actual service before an intelligent opinion concerning it can be formed.

Mr. C. A. McCotter, representing the American Spark Arrester Co., of Indianapolis, Ind., requested the board to send a representative to observe the operation of a device of this character at Purdue University, La Fayette, Ind. Mr. Ewald was delegated by the board to witness this test, which was made on July 26, 1910, under the direction of Prof. Louis E. Endsley.

Briefly described, the apparatus consists of a cylindrical, sheet-iron casing, its axis coincident with that of the smoke box, inserted in the smoke box of the engine. On the inside of this casing an inwardly projecting flange, about 15 ins. wide, arranged spirally, acts as a deflector. Near the front end of the smoke box at the top an opening is left to allow the smoke to pass upward. The action of the device is such that by the time the smoke and cinders have passed through the spiral casing, the cinders will have lost their momentum and will fall to the bottom of the smoke box at the front end instead of passing up through the stack.

Two tests on the laboratory locomotive at Purdue were observed by Mr. Ewald, each covering a period of one hour. The first was made with lignite coal; no sparks were seen coming out of the stack. The second test was made with Indiana mine-run coal, of which 1,452 lbs. were consumed. A speed equivalent to 20 miles per hour was maintained, and the average drawbar pull was 4,800 lbs. As the result of this test, 76 lbs. of cinders were taken from the hopper. In addition, 8 lbs. of very small cinders and soot were caught at the top of the stack in a metal receptacle having an area of 64% of the stack. Means for disposing of the cinders had not been decided upon at the time of this test.

LOCOMOTIVE BOILERS.—Under date of Sept. 21, 1910, the board received a request from Mr. W. F. Buck, Superintendent of Motive Power of the Atchison, Topeka & Santa Fe Ry., to witness a test of an improved form of fire box which was conducted at Topeka, Kan., on Sept. 26. The test was designed to demonstrate whether this particular form of fire box could withstand stresses which, in the ordinary form of fire box, in most cases produce ruptured sheets and result in so-called explosions. Mr. Ewald went to Topeka to witness this test. Mr. E. L. Gibbs, one of the Commission's safety appliance inspectors, also was present on behalf of the board.*

The test demonstrated that with the crown sections of the fire box raised to a temperature of 1120° F. (the water being 4½ ins. below the crown sheet) the construction withstood safely a pressure of 220 lbs. per sq. in. Under similar conditions a fire box of ordinary construction would probably have failed.

MONOGRAPHS.—A majority of those who have presented devices to the board for examination have manifested such unfamiliarity with actual railway operating conditions that it has seemed proper this year, as last, that the board should set forth certain principles of correct design and construction of some forms of railway equipment, appliances, and structures, with a view to showing the present state of the art in such matters and of directing effort along right lines. With these objects in view, the board has had prepared monographs on the following subjects:

(1) The Principles and Mechanical Development of Train Control Apparatus for Steam Railroad Service.
(2) The Car Wheel.
(3) The Electric Track Circuit.

These monographs will appear as appendices to this report. They set forth the state of the art and the principles that must be observed in the development of devices pertaining to each particular field, as well as economic and other considerations that have to do with the practicability of safety devices in actual service.

TRAIN-DISPATCHING SYSTEM.—The board has examined a number of devices which are intended to be used as adjuncts to the train-order or dispatching system, and designed to render station operators less liable to forget or neglect to deliver orders to train crews. While these devices in the hands of faithful and conscientious operators, striving to the best of their ability to avoid error, would probably serve a useful purpose in the handling of train orders under the time-interval system, and to that extent can be recommended, it is important to bear in mind that they do not cure, and, indeed, do not profess to cure, all the dangers of the train-order system.

The board regards all dispatching systems which depend on the use of clocks and watches, on minimum time intervals between trains, and on written orders of various forms transmitted by telegraph or telephone, to be unsafe and comprehended or interpreted by trainmen, as being so far inferior to the block system or space interval that it is not disposed to recommend the use or extension of any such dispatching system in preference to the block system.

In other words, the weaknesses of the dispatching system are so complicated and perplexing that the only comprehensive means of dealing with them is the adoption of the space interval or block system, and the board cannot countenance any improvement in a single feature of the dispatching system without at the same time emphasizing the fact that the system as a whole still remains defective.

A B C SYSTEM.—The A B C system of block signaling which has been in use on the Northern Pacific for about three years past, and an account of which was given in our last annual report, has been abandoned on all but one of the divisions where it was in use, and it is to be abandoned entirely. It was introduced on a short section of the line east of Spokane, Wash., in the autumn of 1907; and the success which attended its use on that section led to its extension to the whole of the division and subsequently to other divisions, making an aggregate length of 681 miles of road on which the system was worked. Following a change of officers of the operating department, it was discontinued on the division east of Livingston, Mont., Feb. 27, 1910; and on the lines west of Cheney, Wash., it was discontinued in August. On the remaining divisions, Paradise to Cheney, 204 miles, the change is about to be made.

The interest which was taken in this system by railroad officers generally was largely due to the increased safety secured by means of it as compared with the method, common on single-track railroads, of conferring on trains the right to the road by means of time tables, dispatchers' orders, etc.; and it was in relation to the efficiency of the system as a means of safety—that is, of preventing collisions—that it was considered by this board. It appears, however, that its adoption on the Northern Pacific was largely because of the economy thereby secured in the movement of freight trains, and the reasons given by the officers for going back to the old system is that, although in the use of the A B C system they secured the advantages expected, so far as freight trains were concerned, there was a disadvantage in that important fast passenger trains were delayed.

The board has not had opportunity to make a thorough inquiry concerning the situation since it was advised of this change; but a letter from an officer of the road indicates that this delay of passenger trains, together with some inconveniences when line wires were broken or otherwise unavailable for use, was the reason for changing.

As the movements of all trains are under the immediate direction of a dispatcher, who has absolute authority throughout his division, it is not clear how freight trains should be unduly favored as compared with passenger trains, except as the dispatchers themselves ordered, or at least approved, such favoring.

Where the A B C system has been discontinued, the company has equipped the line from Billings to Livingston, Mont., 116 miles, with automatic block signals. On that part of the line from Cheney to Auburn, 351 miles, the simple manual block system is used. The manual block system will also be used on the line between Paradise and Cheney, 204 miles, when the A B C system is discontinued on that section.

The Block System.

In its report to Congress of Feb. 23, 1907, on block-signal systems and appliances for the automatic control of railway trains, the Commission indicated the need for investigation under four heads, as follows:

(1) The telegraph block system on the larger roads (mainly double track) as regards the personnel and the routine, the use or nonuse of distant signals, and the practice of permissive blocking.

(2) The telegraph block system on single track lines and minor roads as regards the personnel, the routine, distant signals, and permissive signaling, and also as regards the use of time rules and dispatchers' orders to make up for incompleteness in the block signaling arrangements.

(3) The automatic block system should be investigated on all roads with respect to the efficiency of the apparatus and of the methods of inspection and care, and the integrity of the records of signal operation in respect to their completeness.

(4) The automatic block system on single track lines should be investigated with respect to the features named in paragraph 3, and also as regards the use simultaneously with the block signals of dispatchers' orders and other measures designed to prevent collisions irrespective of the block system.

The work of investigation under these heads was begun by the board during the latter part of 1908, and the results obtained were set forth briefly in its last annual

*Described in EngineeringNews of June 17, 1909. Test reported in issue of Nov. 3, 1910.

report. This work has been continued and extended during the past year, and the results have been briefly summarized and are published as Appendix E to this report.

It will of course be understood that the investigations thus far conducted have not been complete; facilities have been inadequate to permit an exhaustive examination of the problem in all its details. Enough has been learned, however, to make it apparent that the block system, both manual and automatic, on most American railroads, is operated far below its maximum efficiency. The most crying present need is reformation in both personnel and methods of operation. For the safe operation of the manual block, competent and faithful signalmen are absolutely essential. With first-class men, objectionable methods of operation or maintenance may be tolerated without unduly sacrificing safety; but with incompetent or unreliable men even the best methods do not insure safety, no refinement in apparatus or system of rules being sufficient to overcome the weakness due to inexperience, slovenly mental habits, poor training, or lack of proper moral qualities.

The board, in all its preceding reports, has indorsed the recommendation of the Commission to the Congress that legislation looking to the compulsory adoption of the block system be enacted. It has not hesitated to do this, because the art of block signaling is well settled. At the present time only about 66,000 miles of railroad out of a total of approximately 240,000 miles in this country is operated under the block system, notwithstanding the superabundance of evidence that the system has added immeasurably to safety in railway transportation.

The situation is not unlike that which existed at the time the adoption of car couplers and power brakes was compelled by federal enactment. Extensive experiments, supplemented by experience, the good results of which have been universally recognized, have clearly shown a simple course for legislation to take. The introduction of the block system will tend to reduce the collision record in a very decided measure. The board believes so firmly in the advantages to be derived from the use of the block system that it desires again to urge the recommendation of the Commission to the Congress for compulsory legislation requiring its use as the step of foremost importance in promoting safety in railway operation. Relatively inexpensive and simple block systems can, by proper attention to training and discipline of signalmen, be operated with a high degree of success.

The facility with which the space-interval principle can be adopted and put in use on a railroad is well illustrated by the action of the Baltimore & Ohio Southwestern in July last, when the line of that company from Storr's, Ohio, westward to Vincennes, Ind., and from North Vernon, Ind., to New Albany, over 180 miles, was equipped with all the necessary apparatus for the operation of the simple manual block system in less than one week. Sixty-two offices were equipped with telegraph instruments and batteries.

Those who are disposed to look upon this as an extraordinary performance should bear in mind that not much apparatus is required. In this case a new telegraph wire, for use in signaling from one block station to another, was put up the whole length of the line. The wire was strung on the poles of the existing telegraph lines. For some of the block stations the regular station telegraph office afforded with its telegraph apparatus and train-order signal the necessary facilities.

In order to arrange the block sections so that they should be of approximately uniform and not excessive length, a number of new block stations had to be established between the regular stations and, aside from the stringing of the new telegraph wire, this was the principal work that had to be done. To facilitate the movement of freight trains waiting on long side tracks where the engine of a waiting train could not be near the station, telephones were put in at the remote ends of these side tracks and connected to the station office.

While at most of the places on the line in question the switches are not interlocked and signaled, the arrangement, with suitable regulations, does nevertheless provide a good degree of protection for the movement of the trains. The principal element which has to be considered by the railroad company in a change of this kind is the increase in the pay-rolls necessitated by the establishment of new block stations, each of which must be manned by three men (to cover the twenty-four hours of the day) and by the employment of night telegraphers at some of the stations which before were manned only in the daytime.

So fully is the board convinced of the adequacy of a simple manual block system, properly worked, to materially reduce the larger number of collisions which now occur under the time interval and dispatching system that it believes that any legislation compelling the use of the block system should be confined to the broad fundamental principle, so as to leave the railroads the greatest possible freedom in the adaptation of the means to be employed to meet the needs of their service.

Automatic Stops.

Since its organization the board has examined plans and specifications of 140 signal and automatic train-stop devices. Of this number only 16 purely automatic-stop devices have been considered to possess sufficient merit to warrant the board in offering to test satisfactory installations. The devices thus approved, with statements of their present status, are as follows:

(1) Charles E. Duffie, Omaha, Neb. Approved for test Feb. 22, 1908. This is a cab signal and train stop making use of intermittent contact rails. The inventor submitted circuit plan of a proposed installation on the Union Pacific R. R. early in 1910, and stated that he was negotiating with the company for permission to make an installation which would be satisfactory to the board for the purposes of official test. Under date of Nov. 5, 1910, Mr. Duffie informed the board that these negotiations have been successfully concluded and officers of the Union Pacific have given definite orders to make the installation about 40 miles west of Omaha on the main line of the road. Mr. Duffie states that the installation will consist of four signaling points and that two high-speed engines in regular service will be equipped with his cab signal and train-stop apparatus.

(2) A. L. Bower, Boyertown, Pa. Approved for test July 20, 1908. This is a cab signal and automatic train stop, requiring short sections of insulated track rails and the insulation either of a truck from the remainder of the locomotive or of the locomotive from the tender. Permission was secured from the Philadelphia & Reading R. R. to make an installation on that road at the expense of the inventor. Up to date the installation has not been completed, and the board is not aware of any present activity on the part of the inventor looking toward that end.

(3) G. W. Jayne, Washington, D. C. Plans tentatively approved July 20, 1908. This is a cab signal and train stop making use of Hertzian waves, a "wireless" system. The device is designed on correct principles, and the proprietor was advised that his system possessed merit warranting its further development. Since the board's opinion on the above-described system was rendered, Mr. Jayne has submitted plans of another system which he regards as an improvement over the first. These plans cover a system working by induction rather than by Hertzian waves. The plans of this latter system are now under examination.

(4) Perry-Prentice Electric Co., Chicago, Ill. Approved for test July 20, 1908. This is a Hertzian wave or wireless cab signal and automatic-stop system. It has been installed on the Chicago Suburban R. R. (electric) and examined by the board. This installation was not considered suitable for a conclusive test. The board has been advised, under date of Nov. 8, 1910, by the Perry-Prentice Co. that lack of capital alone has prevented them from making an installation for test purposes under conditions that would be satisfactory to the board.

(5) P. J. Simmen, Los Angeles, Cal. Approved for test July 29, 1908. This is a controlled manual block and automatic train-stop system employing intermittent contact rails. This system, without automatic stop, was installed and used on the Toronto & York Radial (electric) Ry., and was inspected by members of the board. No installation has as yet been offered in which the automatic stop was used, and the installation on the Toronto & York Radial Railway does not approximate service conditions on steam roads closely enough to warrant the board in conducting test of that installation.

Mr. Simmen advises, in reply to a recent inquiry, that lack of capital has prevented him from providing such an installation as the board would consider satisfactory for test purposes. He estimates that an installation suitable for test by the board would cost from $15,000 to $25,000, because in order to demonstrate the remote control principle which is a prominent feature of his system it would be necessary to equip an entire division of some road. He advises the board that he has been in negotiation with the Pennsylvania R. R. Co. for permission to make an installation on its Bedford division about 70 miles in length. These negotiations have not yet been successful for the reason, as Mr. Simmen states, that he and the officers of the road have not been able to come to a satisfactory conclusion on the matter of terms covering the cost, which it is stated will be about $12,600 at a minimum.

(6) Railway Electric Signal Co., New York, N. Y. Approved for test July 29, 1908. This is an automatic stop and cab signal of the intermittent contact rail type employing alternating current. It is understood that the proprietor has abandoned further effort on this system in favor of a system working by induction rather than by electrical contact.

(7) H. D. Patterson, New York, N. Y. Approved for test October 1, 1908. This is a cab signal and train-stop system in which electrical devices located along the roadway act inductively to produce effects upon apparatus located on the train or engine. In reply to an inquiry, Mr. Patterson states that he is now preparing for an installation suitable for examination by the board on one of the elevated lines of New York City. He also states that lack of capital has delayed the work of development.

(8) Rowell-Potter Safety Stop Co., Chicago, Ill. Approved for test Oct. 12, 1908. This is a ground mechanical trip automatic train stop and automatic block system combined. It was tested by the board during the winter and spring of 1908-9. (See second annual report.) The board has no information of any working installation of this system having been made.

(9) H. J. Warthen, Washington, D. C. Approved for test, Nov. 2, 1908. This is an intermittent contact rail cab signal and automatic train stop. The device is now being installed on the Buffalo, Rochester & Pittsburg Ry., near Rochester, N. Y., for the purpose of test.

(10) A. H. Fox, New York, N. Y. Plans tentatively approved May 27, 1909. This is an automatic train stop of the magnetic or inductive type, depending for its operation on the nonmagnetic property of manganese steel rails. The inventor was encouraged to develop his system further, and now informs the board that he has secured the use of tracks on the Putnam division of the New York Central road and proposes to make an installation for the purpose of testing the operation of his device with a view to securing definite data regarding particular features; and that as soon as these data have been obtained he will be prepared to offer the board an installation for test purposes.

(11) Gray-Thurber Automatic Train Control & Signal Co., Guy P. Thurber, President, Pittsburg, Pa. Approved for test Oct. 21, 1909. This is a cab signal and train stop requiring short sections of insulated track rails, and the installation either of a truck from the remainder of the locomotive or of the locomotive from the tender. This device is now being installed on the Lake Shore & Michigan Southern Ry., near Cleveland, Ohio, for purposes of test.

(12) S. H. Harrington, New York, N. Y. Approved for test Sept. 15, 1909. This is an overhead mechanical trip automatic train stop. It was tested by the board on the Erie R. R. during the winter of 1909-10. (See Appendix D for results of test.)

(13) Darwin G. Jones, Atlanta, Ga. Approved for test Dec. 22, 1909. This is an intermittent contact-rail cab-signal and automatic train stop. The proprietors have made a preliminary installation on the Roswell branch of the Southern Ry. near Atlanta. This installation has just been completed and has not yet been fully examined so as to determine whether or not it will be suitable for purposes of an official test.

(14) Electrical Automatic Railroad Safety Signal Co., Jacob A. Cantor, President, New York, N. Y. Approved for test May 28, 1910. This is called the Lacroix cab signal and automatic stop; it is an intermittent contact-rail system. This device was installed and exhibited on the Erie R. R., near Nutley, N. J., and has been examined by a member of the board. Plans of an installation which is now being made on the Staten Island Rapid Transit Ry., have been filed with the board, and it is expected that this installation will be ready for official test during the coming winter.

(15) Ross Engineering Co., Chicago, Ill. Approved for test July 22, 1910. This is a cab signal and automatic stop, requiring short sections of insulated track rails at indication points, and the insulation of one truck from the remainder of the engine or of the locomotive from the tender. The board is not aware of any action yet taken looking toward an installation for test purposes, but is informed by the proprietors that the General Railway Signal Co., of Rochester, N. Y., is developing the Ross apparatus and intends to make an installation to test the merits of the system.

(16) Railway Automatic Safety Appliance Co., U. G. Glick, President, Wilmington, Del. Approved for test Sept. 21, 1909. This is a mechanical trip automatic train stop in which the trips are of intermediate height, or about the level of the buffer beam on the locomotive pilot. Exhibitions of the device have been made by the proprietors and witnessed by representatives of the board. The board is informed by the proprietors of this device that arrangements have been made with the Pere Marquette R. R. Co. to make an installation for official test purposes and that work upon this installation is now in progress; it is expected to be completed, ready for inspection, about the middle of December.

It will be observed that only two of the above-mentioned systems, namely, the Rowell-Potter and the Harrington, have so far been fully tested by the board. The Gray-Thurber and the Warthen systems, as well as those of Electrical Automatic Railroad Safety Signal Co. and the Railway Automatic Safety Appliance Co.'s devices, are now in process of installation, and it is expected that they will be fully tested during the coming winter.

In addition to these purely automatic stop devices, the board has approved for test the following cab-signal devices, to which an automatic train stop can be attached, if desired:

(17) E. F. Clement, Philadelphia, Pa. Approved for test Feb. 22, 1908. This is a cab-signal system designed to repeat in the engine cab the indications of fixed signals along the roadway, making use of short sections of insulated track rails and a truck insulated from the remainder of the locomotive, or the locomotive insulated from the tender.

(18) Railway Audible Signal Co. (Limited), London, England. Approved for test Feb. 5, 1910. This is an audible cab signal requiring short sections of contact rail. The apparatus is electrically operated in connection with fixed signals. In operation, when the signals are clear, the contact rail is charged, causing a proceed

indication to be displayed in the cab; when the signals are at stop, the circuit to the contact rail is broken, causing an audible danger indication to be given in the cab. The apparatus is in use on the Great Western Ry. of England, and records of its service were given in the board's last annual report, page 22. The company states that it is now negotiating for an installation in this country for purposes of test.

As set forth in its first annual report the board has considered that as block signals, both automatic and non-automatic, have already been intelligently developed in this country, particular attention should be devoted to the automatic stop, which has not been so fully developed.

Collisions resulting from the weaknesses in the time-interval or train-dispatching system, and the deficiencies in the block system due to untrained or undisciplined signalmen, as well as errors on the part of enginemen and trainmen, have led to public demand for automatic devices. Many seem to believe that the introduction of the automatic-train stop would greatly diminish railroad collisions of all classes.

While it is true that the use of automatic features in the block system itself, as a result of which block signals are actuated directly by the movements of the train, would greatly diminish the number of collisions due to errors in manual block working, the fact should be clearly borne in mind that the automatic stop corrects but one defect, namely, the failure of the engineman to observe, understand, and obey signal indications. It does not in any way insure that the indications displayed will be correct, nor in any way prevent collisions due to the inherent defects of the dispatching system nor to improper working of the block system.

This, however, should not be construed as in any way minimizing the importance of the automatic stop, for it is a well-known fact that many accidents have been caused by the failure of enginemen to observe, understand, and obey signal indications. Failures to observe signals may be due to fog, snow, signal light not burning, or smoke from other trains; failure to understand or comprehend the signals may be due to complexity in the system of indications or to diversion of the engineman's attention or to his physical incapacity; failure to obey indications that are seen and comprehended are rare, and comprise only those cases where enginemen desiring to make time are tempted to take chances, or to a too liberal interpretation of rules which allow the enginemen some discretion.

Experience with automatic stops shows that under proper discipline they perform a moral function in that runners are more careful to heed stop signals when it is certain that disobedience of such signals will be detected.

In the discussion of the first test of an automatic stop made by the board it was deemed desirable to present information which would enable a sound judgment to be formed not only of the merits of the device then tested, but also of other devices to be tested in the future. While certain automatic train-control systems may be superior to others of the same class, it may result that certain classes of systems, when properly developed, will be found far superior to others in the completeness of the protection which they afford. The board therefore formulated and published in its last report characteristics which it believed desirable in every system of automatic train control. These characteristics, with slight modifications in phraseology, and the addition of one other (No. 10), are as follows:

(1) The apparatus should be so constructed that the removal or failure of any essential part would cause the display of a stop signal and an application of the train brakes. If electric circuits are employed, they should be so designed that the occurrence of a break, cross or ground, or a failure of the source of energy in any of the circuits would cause the display of a stop signal and an application of the train brakes.

(2) The apparatus should be so designed that it may be used on the open roadway, on bridges, or elevated structures, in tunnels or subways, and where either steam or electricity is used as the propelling power.

(3) The apparatus should be so constructed as to conform to recognized standards of clearance for rolling equipment and structures, so that those portions of the apparatus placed on the roadway will not be subjected to damage by rolling stock or engines, nor those portions placed on the vehicles be damaged by any structures permitted to exist on the roadway; and at the same time, all vehicle parts and roadway parts which may have to come into operative relation with each other should be so designed that proper operative relation will be assured under all conditions of speed, weather, wear of track or vehicles, oscillation and shock.

(4) The system should operate under all weather conditions which permit the operation of trains.

(5) The system should be capable of control by the ordinary means used for indicating the condition of the block about to be entered, such as electric track circuit.

(6) The engine apparatus should be so constructed as to prevent release of brakes after an application has been made until the train has been brought to a stop, or the obstruction or other condition which causes the application has been removed.

(7) The system should be so designed that should operating conditions require it, speed control may be used; that is, provision made for a train to pass an automatic stop in tripping position without the application of the brakes, provided the speed is less than a predetermined number of miles per hour.

(8) The system should be so designed that when no cause for stopping a train exists, a definite and positive clear or proceed indication will be given at every point where a stop indication would be given or the brakes applied when adverse or dangerous conditions exist.

(9) The system should provide, at least for use under congested traffic, for a continuous display of indications rather than for their intermittent display at certain definite points, as of course is necessary with fixed signals.

(10) The apparatus should be so constructed and installed that it will not constitute a source of danger to trainmen, other employees, or passengers.

It is probable that other conditions may develop as the result of the use of automatic train-control systems which it will be found necessary to meet, and it is possible that experience will develop the necessity for a modification of some of the characteristics described.

Partly as a result of weeding out and discarding impracticable designs during the two preceding years, and partly, no doubt, as the result of study on the part of those devoting effort to the subject, some of the automatic-stop devices examined during the past year have shown more intelligent care in their design and development, and have possessed meritorious features in a greater degree than was true of those previously examined. For this reason the board has been led to offer suggestions and more or less encouragement to a number of persons who are working to produce practicable automatic stops.

In its second annual report the board stated that the principal question to be dealt with in connection with automatic stops is that concerning their applicability to the varied conditions of general railroad traffic and their behavior under adverse weather conditions, and that the experience gained from the use of automatic stops on underground and elevated railroads, which are never seriously interfered with by drifting snow or by sleet and ice, throws but little light on this problem. At that time only one automatic stop, that of the Rowell-Potter Safety Stop Co., had been completely tested under actual traffic conditions, although several had been approved by this board for purposes of such tests. It is very much to be regretted that up to the present time only one additional automatic stop, that of S. H. Harrington, elsewhere described, has been made ready for a test by this board under service conditions.

As both of the stops which have been tested are of the mechanical trip type, there is no information available as to the practical performance of three other types of train-control systems. These other types include contact rail systems, systems requiring the use of short insulated sections of track and the insulation of certain parts of the engine, and systems making use of inductive or magnetic forces.*

Concerning the Rowell-Potter stop the board said:

As regards the system as a whole, the board concludes that if the faults mentioned (in the report) were remedied, and it sees no reason why they should not be substantially overcome, and if the apparatus were well inspected and maintained, the system would be safe and reliable, and its use would tend materially to promote safety of operation on a railroad using it. As to its economy, there is insufficient data to form a conclusion of any real value.

Concerning the S. H. Harrington stop the board said:

The system, with reasonable inspection and maintenance, would be safe and reliable and its use would tend materially to promote safety of operation on a railroad using it.

While the results of the tests on these two mechanical trip devices indicate that their use would materially promote safety in railroad operation, the board considers it manifestly improper to make any recommendations concerning the compulsory adoption of automatic-train stops based on them alone. Such recommendations should be based on the results obtained from tests of all types of devices believed to offer promise of meeting the varied requirements of railroad operation. Some types will meet those requirements in one degree and some in another.

As a result of the recent introduction of automatic stops on some electric roads, and for other reasons, there has been some little development during the past year. One electric surface railroad in the state of Washington, the interurban line of the Washington Water Power Co., between Spokane, Cheney and Medical Lake, has put mechanical stops in use on 27 miles of its line. Signal engineers have been studying the subject more generally. With the extension of electric propulsion of trains, the problem of the use of train stops becomes simplified.

On steam railroads the only sources of mechanical power usually available are the boilers of the locomotives themselves and the steam plants in the shops of the larger yards. Hence, the installation of signaling systems requiring power for their operation has necessitated the installation of engines and pumps for supplying compressed air, or the installation of primary batteries or electrical generators for supplying electrical current for the operation and control of signals. Power generated chemically in primary batteries is expensive, and the losses incident to the transmission of the energy for operating signals over line wires of considerable length are serious.

The substitution of electric propulsion for steam propulsion on railroads provides a readily available source of power for signaling or train controlling apparatus which is continuous throughout the length of the road. The electrical energy for propulsion purposes being generated in large quantities is relatively cheap per unit, and for this reason it is believed that the electrification of steam railroads will tend materially to effect an increase in the extent and efficiency of signal installations. To even a greater extent is electrification likely to encourage the use of the automatic train stop by providing available power for the operation of these devices which, it is believed, will in many cases be found to require for their operation more power than the usual forms of fixed visual signals.

Negotiations between the Pennsylvania Co. and the Gray-Thurber Automatic Train Control and Signal Co. have resulted in an installation of the Gray-Thurber system being undertaken on the westward main passenger track on the Pennsylvania lines, between Jacks Run and R N tower, Glenfield, Pa. It is intended to equip two engines, one running regularly in suburban service, the other running regularly in through-passenger service. As hereinbefore mentioned, the New York Central has offered facilities for a test of the train-control system of Mr. A. H. Fox, between High Bridge and Yonkers, N. Y., on the Putnam Division of that road, and the Washington Water Power Co. has installed mechanical automatic stops, as already noted. These installations, encouraged by the railroads themselves, are significant, and are in line with suggestions contained in our last report, in which it was pointed out that—

> The art of automatic train control, like the art of signaling, must be developed by those most intimately concerned in its use; namely, the railroads themselves. It is not to be expected that trials or tests conducted by the Government will, independently of extended use by railroads, result in the production of devices or systems fully developed to meet all the exacting conditions of railroad operation. The real value of any mechanism can only be demonstrated by its extended use in the place and for the purpose intended.

The most serious obstacle to the practical development of systems approved for experimental test has been the fact that proprietors have lacked the financial means needed to carry on their work. Large sums of money have been spent in private enterprises to develop devices which have been found to possess little merit.

It is a matter of common observation, now as for years past, that devices having no merit succeed in attracting capital by methods scarcely less than fraudulent. Instances of this kind have been observed in connection with devices which have been considered by this board and rejected as worthless.

On the other hand, some devices which appear to possess decided merit have remained undeveloped for lack of money or business ability on the part of their inventors. Inventive faculty and business ability seldom go hand in hand. Under existing law the Commission has no authority to expend money except in connection with the investigation of such systems and appliances as shall be furnished for investigation free of cost to the Government. The board has seriously considered whether the objects of the investigation contemplated in public resolution No. 46 and its appropriation act might not be more speedily and effectively accomplished by a provision authorizing the expenditure of money for the development and installation of meritorious devices under regulations similar to those adopted by the German Government.* In view, however, of the very great expense that would be involved, and of the fact that the Government has no permanent railroad (except in Panama), such a scheme would be difficult of accomplishment.

A difficulty of a different sort confronts the railroads. One objection which has been urged against the introduction of new safety appliances is that after a partial introduction of them a liability for damages might exist in connection with accidents on parts of a railroad not

*While an installation of the latter type, as embraced in the Perry-Prentice Hertzian wave system, has been examined, the conditions under which it was operated were not those to be found in general railroad practice. The results, however, indicated sufficient promise to warrant the encouragement of further experiments and an installation of the system on some railroad where its actual merits could be more completely demonstrated.

*Experiments have been carried on during the past six years in a number of different districts of the railway system owned or controlled by the German Government looking to the selection of the most practicable and suitable device for preventing the overrunning of stop signals by enginemen. The results, while interesting, have as yet shown nothing that is conclusive, beyond what has been learned by experiments made in this country and in England. Automatic stops have not been favored at all, the German Railroad Union, a quasi-official body, having voted that the desideratum was an indication in the cab to warn the engineman. One "wireless" apparatus was tried. So far as this board is informed, the only change in practice that has been introduced as a result of the investigations is the limited or tentative adoption by five different directorates of a "recording alarm," an apparatus for recording automatically on a locomotive each instance in which a stop signal is disregarded by the runner of that locomotive and compelling him to report himself.

yet equipped with them. It has been suggested that such a situation might be met and the objection entirely overcome, so that no injustice would be done to the railroads, by a simple enactment that the partial application of such devices should not of itself create any legal obligation to equip the entire line in the same manner; that such fact should not be admitted as evidence in any court of an obligation to equip any part of a road not already equipped; and that any case of damage occurring on any portion of a road not equipped should be determined without consideration of the installation on another part of the road.

The board considers it no part of its duty to suggest the form of such legislation, but it is quite possible that some legislation of the character indicated, as a matter of justice to the railroads and to remove from the minds of railroad managers any prejudice against the tentative application of devices intended further to safeguard the public and the railroad trainmen, would be proper. The enactment of such a law would tend to promote the development of the appliances under consideration.

While the board confidently expects the automatic stop to be developed to a point where, like the block signal, the car coupler, and the train brake, it will be available to railroads generally, and in many situations will constitute one of the factors promoting safety in train operation, the board is led to believe from its study of existing conditions, particularly as found in connection with the means now employed for the safe movement of trains, that the primary cause of the lamentable record of collisions in this country is of so serious a nature as not to be susceptible to complete cure by any mechanical means. It is not to be considered that the automatic stop, or that any automatic device, will be a panacea for all the faults at present existing in train operation. The question really is whether by the introduction of automatic devices the percentage of accidents due to those faults can be reduced.

It is an unwelcome thought that the fundamental responsibility for the relatively large number of collisions in this country is chargeable to railroad officers and employees; not to them because they are more careless or less sensible of their responsibilities than men in other vocations, for that can not be truthfully said, but simply because they possess the qualities, mental or temperamental, which are the cause of these deplorable results, and which are symptomatic of characteristics common to all who have been reared in a new and rapidly developing country. But sober reflection leads inevitably to the conclusion that, outside of the army and navy, the American is not reared with that discipline which becomes a part of the man and governs his actions mechanically, as it were, rather than as the result of reasoning.

Such discipline leads to action as one's first duty without question or reason, and the sense of duty is the one predominating quality which influences the man's every action unconsciously and unfailingly. This conclusion is brought home all the more convincingly when one reflects that nowhere in the world have appliances for safeguarding railroad transportation been so highly developed as in this country, notwithstanding which nowhere in the world is there a greater proportionate number of accidents of the kind which such advance in the art should prevent. The automatic stop, therefore, while it might be unnecessary under different social conditions, may be expected to add to safety in train operation under the conditions which do exist and must continue to exist in this country until we shall come to appreciate and realize all that may be accomplished by discipline of the right sort. But mere discipline will not suffice alone. There must go with it the spirit which prompts obedience for the pleasure of being approved by one's own conscience.

It being admitted that what is most needed is automatic performance of one's duties rather than automatic mechanical devices, how may it soonest be brought about? The causes that militate against the development of the human machine to perfection of disciplined action are so complex and so interwoven with our social being that many of them can be eradicated only by that slow evolution or growth which results from the operation of natural laws and which can hardly be forced or even guided by the enactment of man-made statutes.

Nevertheless a number of these causes appear susceptible of marked and present improvement. Appeals to conscience may develop a high sense of duty in many men, but the ever-present problem of earning a living, by its very insistence, makes the appeal to self-interest powerful and practical. The pension system as in force on a number of prominent roads and as advocated by the board in its report last year is believed to offer a strong inducement to careful conduct and should be encouraged.

The existence in the regulations of some railroad companies of rules that are unfair or non-enforceable, and intended only as an extreme legal precaution to protect the companies, is nearly as bad in its effect upon discipline as the failure of railroad officers to rigidly enforce those rules which are proper and necessary to safeguard traffic.

The American Railway Association some years ago prepared, and with painstaking effort has since amended and improved, its standard code of rules governing train operation. It is unable to compel their use or their uniform interpretation and enforcement on individual roads. The causes heretofore mentioned and others affecting discipline have the bad effect of impelling railroad employees to move about from one road to another. This tends to decrease safety in operation by frequently placing men in unfamiliar surroundings; and the condition is made still more undesirable by the lack of uniformity in rules and procedure on different roads.

A case where, on a single-track railroad 150 miles long, used jointly by the trains of three different companies, a system of whistle signals is used on the trains of one company which is entirely different from that used by the other two, is an aggravated example. Legislation in at least one state requires railroad companies to file copies of their operating rules with the State Railroad Commission, and makes any infraction of the rules by an officer, agent or employee a misdemeanor. From this to a federal requirement of the same nature, and, what is more important, enforcing uniformity, is but a short step and one likely to be advocated in the absence of an improvement in railroad procedure in this respect.

The law passed by Congress at its last session authorizing the Commission to investigate train accidents, should tend to make for better methods and improvement in personnel by directing public attention to those defects and deficiencies which have resulted in train accidents, and thus lead to their correction. But on the theory that prevention is better than cure, it is obviously the part of wisdom to take all practicable measures beforehand to prevent those evils that have heretofore resulted in collisions rather than to wait for the occurrence of accidents to disclose the existence of the evils. Investigations such as the board has been conducting into block-signal and other operating methods, therefore, should be continued and conducted on a larger and more comprehensive scale than has been done in the past. This is necessary, with or without a law requiring the use of the block system.

Again the board desires to express its obligations to the American Railway Association for its cooperation in securing the consent of railroads for the installation of apparatus on their tracks for purposes of test, and to the officers of railroads who have extended courtesies which have made it possible to conduct practical investigations in the field.

M. E. Cooley, Chairman; Axel Ames, F. G. Ewald, B. B. Adams, Block Signal and Train Control Board. W. P. Borland, Secretary.

The Second Annual Convention of the Organization of City Officials for Standardizing Paving Specifications.

This organization is the result of a convention called last February by Mayor Busse of Chicago. It is composed of city engineers and officials who are to meet once a year, and through the aid of committees, draw up and revise standard forms of specifications for city pavements. The specifications as reported by the committees and adopted by the conventions are in no wise binding on the municipalities belonging to the association, but are intended merely as guides, embodying the essential features of the best specifications.

The second annual convention was held in New York City, in the United Engineering Societies Building, Jan. 10-13, 1911. Thirty-two cities, including practically all the larger ones with the exception of San Francisco and Seattle were represented by 73 delegates.

The first three days of the convention were taken up almost wholly with committee work. On Friday the various committees were called upon to report.

The Committee on Concrete Pavement, Mr. N. E. Murray of Chicago, Ill., Chairman, reported, that because of the lack of experience with this type of pavement, the committee hesitated to recommend unreservedly the adoption of the reported specifications. Several minor additions and changes were made in the specifications adopted last year. The committee recommended that a permanent committee should be appointed to study this kind of pavement; that under conditions where traffic was light and economy and cost essential considerations, a concrete pavement could be used to advantage.

The discussion following the report of the committee dealt wholly with the period of the maintenance guarantee. The convention was unable to agree upon any period at this time.

The next committee to report was that on Macadam Pavements, Mr. James L. Darnell of Kansas City, Mo., Chairman. The committee in presenting this report called attention to the fact that it was impossible to have specifications to cover all points to be met with in foundation, material and kind of traffic for different localities, and recommended specifications adapted to each particular locality. No maintenance clause was placed in the reported specifications as it was the opinion of the committee that it was possible to test the materials and inspect the workmanship in such a manner as to make maintenance guarantees unnecessary burdens.

In the course of this discussion the period of guarantee for concrete pavements again came up. Messrs. Norton and Murray of Chicago stated, that from their experience, a one year guarantee was entirely too short a time for imperfect materials and workmanship to become manifest. A vote was then taken whether the maintenance period for concrete pavements should be one year or two years. The vote of the convention stood 10½ to 5½ for a two-year period.

In voting, each city was allowed one vote but the votes of each delegate were recorded. Thus the two delegates of one city by voting on opposite sides give a fractional form of result. This caused some confusion. Nor was it lessened when a discussion took place as to whether a city which had two or more delegates, supposedly at the convention but invisible at the sessions, should have its vote determined by its one delegate who happened to be present, or whether the delegate's vote should count only ½ or ⅓ as the case might be. After a considerable discussion, involving more time than was given to the consideration of some of the paving specifications, it was determined that because certain delegates were missing, it was not necessarily a correct presumption that they would have voted against their colleague, and therefore it was determined that the vote of the member present determined the vote of the city he represented.

The Committee on Bonds, Guarantees and Uniform Bidding Blanks, Capt. W. J. Hardee of New Orleans, Chairman, next reported. Bonds were not recommended for large cities which have ample testing facilities. The committee had conferred with representatives of the large bonding companies and letters from officials of these companies were laid before the convention.

The Committee on Creosoted Wood Block Pavements, Mr. George W. Tillson of New York, Chairman, next reported. Mr. Tillson said that the specifications of last year on treatment of blocks, wherein an oil with a specific gravity of 1.10 was specified, had been adversely criticized, but that from further study of the case, and after consultation with numerous experts the committee was still of the same opinion regarding this point.

The Committee on Brick Pavements, Mr. Edwin H. Christ of Grand Rapids, Chairman, reported that the absorption test of bricks had been unanimously struck out of the specifications. The rattler test was recommended and specifications covering the same in all details were given. A guarantee period of 5 years was recommended.

The Committee on Bituminous Concrete, Mr. Linn H. White of Chicago, Chairman, reported that this treatment was particularly recommended for old macadam roads. Careful analysis of the cement was recommended for each case and specifications adopted to this particular cement. A discussion followed on the paragraph dealing with the penetration test of bitumen. Several delegates contended that the clause as written would shut out a very good quality of California bitumen. The paragraph was then omitted from the specifications as adopted.

The Committee on Sheet Asphalt, Mr. George W. Craig of Omaha, Chairman, reported substantially the same specifications as last year with additional clauses on dilution tests for asphalt. Several clauses were also added for asphalt block pavement.

The Committee on Stone Block Pavements failed to report to the convention and it was voted that the report be accepted for publication in the proceedings with an explanatory note.

The convention then proceeded to elect the following officers: President, Mr. George W. Tillson, M. Am. Soc. C. E., Chief Engineer of the Bureau of Highways, Borough of Manhattan, New York City; 1st Vice-President, Capt. W. J. Hardee, M.

Am. Soc. C. E., City Engineer, New Orleans, La.; 2d Vice-President, Mr. L. W. Rundlett, M. Am. Soc. C. E., Commissioner of Public Works of St. Paul, Minn.; 3d Vice-President, Mr. George W. Craig, M. Am. Soc. C. E., City Engineer of Omaha, Neb.; 4th Vice-President, Mr. Faris, of Kansas City, Mo.; Secretary and Treasurer, Mr. John B. Hittell, M. Am. Soc. C. E., Chief Engineer of Streets (Board of Local Improvements), Chicago, Ill.

Mr. Tillson then took the chair and made a short address in which he summed up the work which had already been accomplished and all that it was hoped would grow out of this association. He explained how the different cities by a small annual fee obtained the services and opinions of experts, which would cost them several thousands of dollars to obtain severally and individually. The convention then adjourned with the understanding that there was to be at least one more convention and permanent organization was left to the determination of an Organization Committee.

A POWDER MILL EXPLOSION at San Martin, Argentine Republic, Jan. 10, killed 12 persons.

THREE COAL BARGES WERE WRECKED on the Cape Cod coast, near the Peaked Hills Life-Saving Station, Jan. 10. Seventeen men were drowned.

THE STEAMER "MARIA RUSS," bound from Hamburg for Nantes, went aground near Norderney Lightship, off the French coast, Jan. 11. Twelve of the crew were drowned.

A FACTORY FIRE AT CHICAGO, ILL., Jan. 12, destroyed the works of the Northwestern Terra Cotta Co., with a loss estimated at $450,000.

The buildings of the Philadelphia Brick Co., at 23d St. and Passyunk Ave., Philadelphia, were destroyed by fire Jan. 10. The loss is estimated at $25,000.

A 20-FT. FLY-WHEEL BURST in the engine-room of the B. B. & R. Knight Cotton Mill, at Sutton, Mass., Jan. 9. Pieces of the wheel were thrown through the roof, doing damage estimated at $20,000. The accident is ascribed to the failure of a belt which was damaged by water used for extinguishing a small fire on an upper floor of the mill.

THREE BACK HEADERS of a Babcock and Wilcox water-tube boiler on the battleship "Delaware" blew out on Jan. 17, during a trip from Guantanamo, Cuba, to Hampton Roads. Capt. C. A. Gove has reported that eight firemen and coal passers were killed and that one fireman was injured. These nine men constituted the whole force on duty in the fire-room. Ten back headers were damaged on this boiler. A board of inquiry is making an examination but no report has been made. The "Delaware" went into commission April 4, 1910.

AN EXPLOSION OF NATURAL GAS wrecked a 5 and 10-ct. store at Connellsville, Pa., Jan. 12. Five persons were killed and a dozen others injured. The meter on the natural gas line in the basement of the store had been removed, according to reports, and the workmen had neglected to cap the supply pipe. The escaping gas was soon detected and a man had started for the basement to investigate when the explosion occurred.

A REAR COLLISION between two passenger trains on the New York Central & Hudson River R. R. at Batavia, N. Y., Jan. 13, resulted in the death of five passengers, while many others were injured. The Western Express was standing at the Batavia Station when struck by the Boston and Buffalo Special. The rear car of the express, a Pullman sleeper, was telescoped and all of its passengers either killed or injured. The accident occurred during a fog and while the rails were covered with sleet. The collision is ascribed to the failure of the engineer of the special to observe the block signals.

PANAMA CANAL EXCAVATION during the month of December totaled 2,946,404 cu. yds., a daily average of 115,323 cu. yds. for each of the 26 working days. During the month 150,176 cu. yds. of concrete was laid and 520,601 cu. yds. of fill placed. The rainfall for the month was 14.43 ins.

CONCRETE WORK IN THE GATUN LOCKS.—One million cu. yds. of concrete had been placed in Gatun Locks at the close of work on Dec. 31, and there yet remained to be placed 1,085,000 cu. yds. The work was begun at Gatun on Aug. 24, 1909, and the mixing and handling plant had not thoroughly found itself until Jan. 1, 1910. In the year just closed, the average amount placed each month was over 73,000 cu. yds. All of the wall and floor of the upper lock chambers have been completed, and the concrete laying is advancing in the upper forebay and the lower gate abutments. About 80% of the masonry for this pair of locks is already in place. In the middle locks, the concrete is being placed in the side and center walls, and three of the four cableways are engaged in this work. The construction plant works 12 hours daily, and the auxiliary plant 9 hours.—"Canal Record," Jan. 4.

Personals.

Mr. C. W. Bradley has been appointed Inspector of Transportation of the Chesapeake & Ohio Ry., with headquarters at Richmond, Va. Mr. Bradley was General Superintendent of the West Shore Ry. from 1885 to 1898, since which time he has been Manager of the Western New York Car Service Association.

Mr. L. E. Perry, until recently connected with the design and construction of the Pennypack Creek sewage disposal works of the city of Philadelphia, Pa., has been appointed Secretary and Engineer of Houston, Perry & Co., Seaford, Del.

Mr. Henry Manley, M. Am. Soc. C. E., has resigned as Assistant Engineer with the City Engineer of Boston, Mass., having served in this office for nearly 42 years. Mr. Manley's resignation, which took effect on Dec. 1, 1910, was caused by poor health and advancing years.

Mr. J. L. Jacobs, who has been engaged in engineering investigations and designs for the Chicago, Milwaukee & St. Paul Ry. since 1909, has been appointed Assistant Engineer and Examiner of Efficiency with the Efficiency Division of the Department of Civil Service of Chicago, Ill.

Mr. Albert E. Kastl, M. Am. Soc. C. E., of New York City, has been appointed Special Deputy in charge of New York State Barge Canal work, by State Engineer Bensel. The salary of this position is $6,000. Mr. Kastl succeeds Mr. William B. Landreth, M. Am. Soc. C. E., as a result of the change in dominant political parties in New York State.

Mr. H. Thurston Owens, a consulting engineer of New York City, has been appointed Associate Editor of "The American Gas Light Journal," of New York. Mr. Owens has been connected with the lighting industry for several years and has been a frequent contributor to the technical press. He is a member of the American Gas Institute, the Illuminating Engineering Society and a corresponding member of the British Illuminating Engineering Society.

Mr. James C. Inglis, Past President, Inst. C. E., General Manager of the Great Western Ry., and Mr. William H. Lindley, M. Inst. C. E., of the Canals Commission, were among those knighted by King George V, in the recently announced New Year's Honors. Readers of Engineering News will recall the presidential addresses of Mr. Inglis which were reprinted in this journal and also the reports on waterways transportation by Mr. Lindley, from which we have published extracts.

Professor Dugald C. Jackson, President of the American Institute of Electrical Engineers, has been retained by the British Government as an expert advisor in the matter of the valuation of the National Telephone Co., which the government is about to purchase. He sailed from New York on Jan. 18 and expects to return to that city on Feb. 7. Prof. Jackson is well known in connection with his work on the appraisal of the Chicago Telephone Co.'s plant and the regulation of telephone rates in Massachusetts which was described in Engineering News of Oct. 20, 1910.

Mr. Geo. H. Frost, President of the Engineering News Publishing Co., and Mr. Paul S. King, who was formerly Chief Engineer of the Lehigh Valley R. R. Company's extension to Buffalo, are to sail from New York Jan. 21 by the Hamburg-American Steamship "Bluecher," on a three months' excursion to South America. The vessel will stop at Barbados, at Pernambuco and Santos in Brazil and at Montevideo and will then sail south through the Straits of Magellan and up the west coast of South America to Valparaiso. Here the party will disembark and travel by rail over the Trans-Andean Ry. to Buenos Ayres. After a stop here Messrs. Frost and King will take a north-bound steamer and will make stops at Rio Janeiro, Bahia, Para and other points. The return to New York is scheduled for April 5.

Mr. Eugene Joseph Armand Duquesne, an architect of the French Government and winner of many famous prizes and medals in architecture, has been appointed Professor of Architectural Design at Harvard University. Mr. Duquesne was born in Paris in 1863. He began his studies in the Ecole Nationale des Arts Decoratifs where he won three of the grand prizes. He then entered the Ecole des Beaux Arts in the atelier of M. Pascal, Member of the Institute of France. From 1896-97 he was Superintendent of Construction on the Grand Palais du Champs Elysees, one of the most notable permanent buildings of the Paris World's Fair in 1900. In 1897 he received a diploma of Architect from the government of France. In 1905 he opened an atelier for students which he has conducted with much success. In July, 1908, he was appointed Government Architect in charge of the restoration and repairs of the palace and gardens of Versailles and Trianon, which position he still holds.

Obituary.

H. T. Eckert, a civil engineer of San Francisco, Cal., where he had practiced his profession for 27 years, died on Jan. 4 from typhoid fever. He was 52 years old and a native of Germany. He leaves a widow and a daughter.

Charles R. Trask, a prominent contractor and building mover of Springfield, Mass., died in that city on Jan. 9, aged 61 years. His greatest achievement is said to have been the raising of the South End Bridge over the Connecticut River.

William H. Browne, Assoc. Am. Inst. E. E., died on Jan. 14, from a cancer, at his home in Brooklyn, N. Y. He was born in Troy, N. Y., on Dec. 3, 1849. He was engaged in the building of the Richmond, Va., electric street railway, one of the earliest in the United States. Later he became General Manager of the United Electric Light & Power Co., of New York City for the Westinghouse interests. He was in charge of this company at the time the first high-potential alternating-current generators were used for lighting purposes. He went next to Montreal to take charge of the Royal Electric Co., where he changed the system from 120 volts to 2,400 volts and installed a polyphase system of current distribution. The power plant on the Richelieu River, at Chambly Rapids, was built under his management, as was also the Cataract Power Co., at Hamilton, Ont.

He was one of the organizers of the Montreal Light, Heat & Power Co., which was a consolidation of Chambly Mfg. Co. and the Royal Electric Co. On Jan. 31, 1902, he resigned as the head of this company to become General Manager and Treasurer of the Stanley Instrument Co., of Great Barrington, Mass. When this company became merged with the General Electric Co., Mr. Browne went to New York City, where he opened offices as a consulting engineer. At the time of his death he was engaged, as General Manager of the Rockingham Power Co., in building a large hydraulic power plant in North Carolina. He was a member of several New York clubs and a past grand master of the Knights of Columbus. He was a widower and leaves five children.

Engineering Societies.

COMING MEETINGS.

ILLUMINATING ENGINEERING SOCIETY.
Jan. 20. Annual meeting at New York City. Secy., P. S. Millar, 29 West 39th St., New York City.

KANSAS ENGINEERING SOCIETY.
Jan. 20-21. Annual meeting at Topeka, Kan. Secy., W. S. Gearhart, Kansas State Agricultural College, Manhattan, Kan.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 24-26. Annual meeting at New York City. Secy., W. M. Mackay, P. O. Box 1818, New York City.

OHIO ENGINEERING SOCIETY.
Jan. 24-26. Annual meeting at Columbus, Ohio. Secy., C. J. Knisely, New Philadelphia, Ohio.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 24-27. Annual meeting at Winnipeg, Man. Secy., C. H. McLeod, 413 Dorchester St., Montreal, Que.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 25-27. Annual meeting at East St. Louis, Ill. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago, Ill.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 6-11. Annual convention at Louisville, Ky. Secy., T. A. Randall, Indianapolis, Ind.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 15. Annual meeting at Boston, Mass. Secy., N. W. Gifford, 26 Central Square, East Boston, Mass.

IOWA ENGINEERING SOCIETY.
Feb. 15-17. Annual meeting at Des Moines, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.
Feb. 28-March 1. Annual convention at Minneapolis, Minn. Secy., Harvey B. Smith, 834 Security Bank Bldg., Minneapolis, Minn.

CANADIAN MINING INSTITUTE.
March 1-3. Annual meeting at Quebec, Que. Secy., H. Mortimer Lamb, Windsor Hotel, Montreal, Que.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.
March 6-11. Annual convention at Toronto, Ont. Secy., Wm. Snaith, 57 Adelaide St., East, Toronto, Ont.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 21-23. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago, Ill.

CENTRAL RAILWAY CLUB.—The annual meeting and dinner was held at Buffalo, N. Y., Jan. 12. At the business session in the afternoon, Mr. W. O. Taylor presented a paper on "Lubrication for High Pressure Slide and Piston Valve Locomotives."